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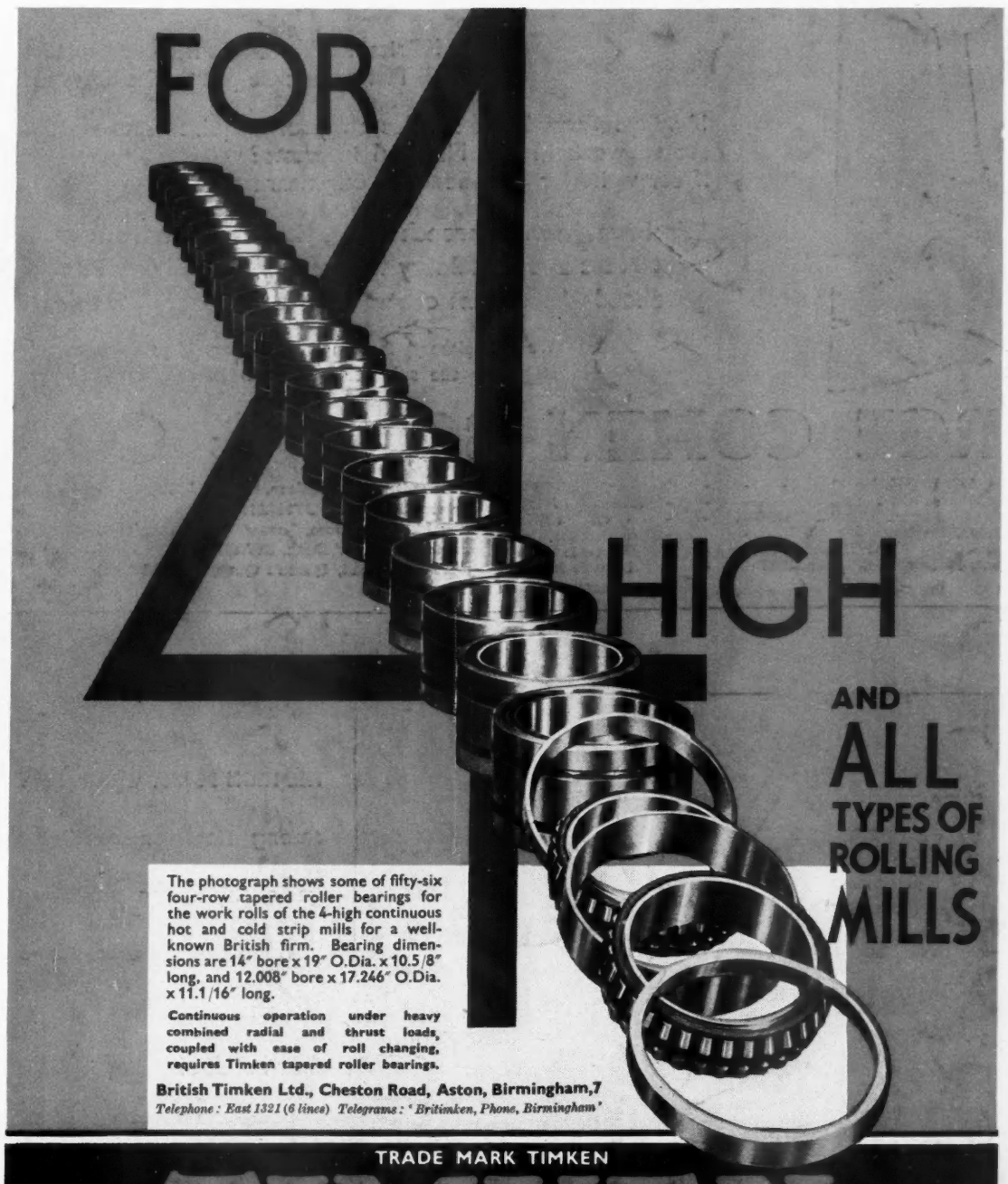

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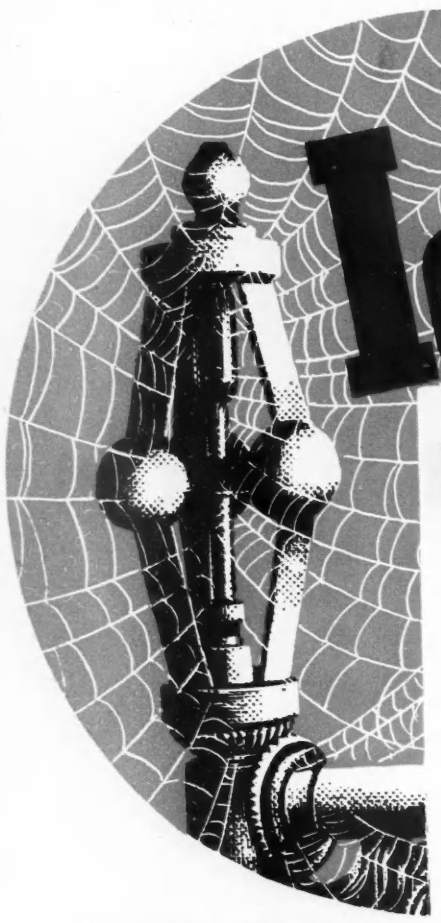

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A Seven-Day Journal

Flood Protection in the London Tubes

An announcement issued by the Ministry of Information gives a short account of the work in progress on that section of the Northern Line between Kennington and Strand, which has been closed to traffic since Thursday, August 31st. At this point of the line the tube tunnels run under the river and electrically-operated flood gates, which can be closed across the tunnels, are being installed at Waterloo and Strand on the Charing Cross branch of the railway, in order to enable these sections of the line to be isolated during an air raid, so as to prevent any possibility of flooding which might arise as a result of damage to the tunnels under the river. On the Bakerloo line, which also runs under the river, flood gates have been installed at Waterloo and Charing Cross. As a temporary precaution while the work of installation is in progress on the Northern Line, concrete bulkheads have been constructed in the tunnels at Charing Cross and Waterloo. These will be removed as soon as the flood gates are in position, and the normal train service will then be restored, the gates only being shut when an air raid warning is received. The gates, which are made of built-up steel, slide horizontally into position within a specially constructed framework and they are designed to be operated either electrically or by hand. For their power operation, which is controlled by a push-button, alternative supplies of electric current are available. The gates are designed to resist a force of 200 tons, which is far in excess of any pressure that might have to be borne. They can be closed within three minutes of the order to close them being received. The gates on the Bakerloo line have been closed during each of the recent air raid warnings, and their closing was accomplished well within this time limit. An interlocking device, which ensures that the gates cannot be closed while there is a train on any of the sections of the line isolated by the closing of the gates, is provided. A specially-trained staff is in continuous attendance at each of the gates, and the closing signal is acknowledged electrically from the operators' control cabins, in which are illuminated diagrams indicating whether the under-river sections of the line are clear of trains or not. The sections of the northern line between Moorgate and London Bridge are also temporarily sealed with concrete bulkheads, and the London Passenger Transport Board now awaits the decision of the Ministry of Transport as to whether flood gates should be installed.

Port of London Improvements

The annual report of the Port of London Authority which covers the year ended March 31st, and which has just been issued, gives particulars of the works and improvements carried out during the year under review. New warehouses have been completed or are approaching completion at the Surrey Commercial Docks, and a 25 ton Scotch derrick has been erected. At the India and Millwall docks, there have been improvements in the sheds, quays, and railway connections, and work is in hand for the deepening and reconstruction of the Millwall entrance lock and the reconditioning of the dock gates and machinery. In the Royal Victoria Dock, old jetties have been demolished and new warehouses are to be built, while the work of deepening the dock to a depth of 31ft. is nearing completion. Improvements in roads and accommodation have been completed at the Royal Albert Dock, the Tilbury Docks, and the Tilbury Landing Stage, and new 3 ton electric cranes are being supplied for several docks. Other works completed include the reconstruction of a considerable length of the river embankment between Richmond and Kew Gardens. Two new launches have been ordered for harbour work, and three additional steel pontoons are under construction for use as dummy barges at the Royal group of docks. Two pairs of lock gate barges are being reconditioned and fitted with steel cradles for use in repairing when necessary the larger dock gates, particularly those at King George V Lock and Tilbury Upper Lock.

London Passenger Transport Board

The London Passenger Transport Board regrets to announce that, notwithstanding an increase in its passenger takings, the financial results for the year to June 30th, 1939, do not warrant a final payment of interest on the "C" Stock; an interim payment of 1½ per cent. was made on March 27th last. Not only were the Board's expenses higher in the year to 30th June, but when at the end of the financial year the final account of the Pooling Scheme between the Board and the Main Line Railway Companies became available, it was found that owing to a general increase in expenses the amount due to the Board under the Pooling Scheme was less than had been anticipated. Appropriations to reserves have been made on the same basis as in the previous two years but owing to further capital assets being brought into operation during the year, an additional sum of £145,000 has been placed to the reserve for renewal. During the year the Board took steps in conjunction with the Main Line Railway Companies to secure a revision of fares in the London Passenger Transport Area. This revision could not become operative until June 11th and, therefore, no material benefit was secured during the Board's financial year to June 30th, 1939. For the period from June 11th to September 1st, when the Government took control of the Board's undertaking, the increased receipts from the revised fares fully realised the Board's estimates. Negotiations are proceeding with the Government with regard to the financial terms covering the period of control, but no settlement has yet been reached. The Board also announces that, in compliance with Sections 47 and 48 (3) of the London Passenger Transport Act, 1933, as amended by Section 87 of the London Passenger Transport Act, 1936, it will shortly transmit to the Minister of Transport the Report and copies of the Statement of Accounts and Statistics and of the Auditors' Report for the year ended June 30th, 1939, which will also be on sale at the price of one shilling at the offices of the Board, 55, Broadway, Westminster, London, S.W.1.

"Safety First" in War Time Industry

In a message to the National Safety First Association welcoming its decision to maintain its industrial accident prevention work during war time, Sir Duncan Wilson, H.M. Chief Inspector of Factories, states that every person injured by industry is a loss to the resources of the nation, just as he would be if injured in a militant activity. Sir Duncan goes on to point out that the adverse effect of industrial accidents on national efficiency is probably even more pronounced in war time than in peace. For war purposes the nation's ability to produce goods and a fighting force, depends ultimately on the sum total of people who can be mobilised to work and to fight. During war time there will be many new factors all tending to increase the chances of factory accidents. There is the dilution of skilled labour by unskilled. Even more potent is the invasion of industry by adult workers who are not only unskilled but are totally unused to factory conditions. There are longer hours of work and intensified production; there is probably a greater amount of monotonous work. In the early days there will also be a certain amount of disorganisation and reorganisation due to change over of personnel and plant to meet new conditions. All these things are likely to have an adverse effect on the accident problem. Perhaps the most serious because of its universal occurrence will be the influx of the inexperienced into industry. This may be aggravated by lack of time to give as much individual instruction as is desirable. The implication is obvious. The educational side of accident prevention will have to be considerably intensified and propaganda will have to be much more widespread if avoidable accidents are not to have a serious effect on national resources. There should be no excuses; no question of lack of time to deal with safety. The disorganisation and waste of personnel, materials, and plant caused by accidents would be far greater trouble and loss than any time given to preventive measures.

Producer Gas Vehicles

In a recent speech made in the House of Lords, the Duke of Montrose raised the question of the use of producer gas for transport vehicles, and said that while restrictions were properly being made in respect of the limited amount of petrol which was available for transport purposes, the Government did not appear to be taking adequate steps to develop alternative fuels or means of propulsion. Germany, he stated, had now more than 10,000 producer gas vehicles on the roads, France 7000, Italy 3000, Australia 600, and Great Britain only 200. The Duke went on to say that he was acquainted with a bus company in the Highlands of Scotland which had operated with great success a 22-seater vehicle running on producer gas for over a year. On daily service that vehicle had covered over 50,000 miles, and the company was so satisfied that a 32-seater bus had been ordered. Since the restriction of petrol supplies his office had been besieged with enquiries about producer gas for road transport purposes, but he could do nothing because the Government said that gas production was not considered to be war or munition work. In the course of a reply for the Government the Earl of Fortescue said that considerable interest had been taken by the Government in the use of compressed gas and tests had been made with vehicles under actual operating conditions. The results had indicated that the use of compressed gas in cylinders was a practical and efficient means of operating vehicles. He had to point out however that the capital cost was not inconsiderable. While the Government was most anxious that everything possible should be done in this particular field of development, the relative importance of the different demands on the available manufacturing facilities had to be considered. The development of the producer gas vehicle had been slow, because the technical and other problems were not free from difficulty. The use of coal and coke instead of charcoal produced he said, new difficulties. The Government was, he continued, carrying out experiments, and he hoped to be in a position to make a statement within a relatively short time.

The Control of Lighting

In reply to a question in the House of Commons, Captain Wallace, the Minister of Transport, stated that in collaboration with the Secretary of State for Air and the Minister of Home Security, experiments were at present being conducted with a view to ascertaining whether any relaxation of the existing restrictions on railway lighting was possible. In the meantime the railway companies were, he said, fully alive to the importance of doing everything they could to promote the comfort of their passengers, and bulbs showing a blue light were being fitted in all trains. From our own experience we find that some of these lamps are so dim that they scarcely show whether the seats are occupied or not, and reading or writing is out of the question. Meanwhile, the officials of the Pullman Car Company have successfully solved the problem of providing their passengers with adequate light for their comfort, without infringing any of the black-out regulations which are now in force. In all Pullman rolling stock, the windows have been fitted with thin plywood shields, in the centre of which there is an opening about 12in. by 18in. which can be closed by a shutter, but which during the daylight hours remains open. All doors in the Pullman cars are heavily curtained so that there is no risk of light escaping. The problems which are presented by the saloon coach with a central corridor or ordinary corridor stock, also the non-corridor suburban stock, present their own difficulties, but the hope may be expressed that the experiments which are now being made may eventually show in what way these difficulties can be overcome. On the rolling stock of the London Underground Railways the use of low wattage lamps without blue colouring is being tried on the emergency lighting circuits.

A Hunted Submarine

The dramatic story of the Cammell-Laird built submarine which while on patrol duty in the North Sea came into contact with enemy forces and escaped after being practically disabled by depth charges, was officially released to the Press on Thursday evening, October 5th. It is a remarkable tribute to the way in which British submarines are built, the reliability of their engines, and the resourcefulness of the engineering and navigating staffs. The submarine left our shores on patrol duty, and passing through a heavy gale found herself early one morning at her allotted patrol area in enemy waters. The detonation of a depth charge close to her showed however that she was being hunted, and she went to the bottom and remained silent to await events. During the next hour six explosions were recorded as the enemy searched for the submarine with sweep wires, electrically operated bombs, and depth charges. In the following hour the bombardment was intensified and explosions followed at the rate of one every two minutes, after which the sounds grew more distant. About tea-time a sweep wire was again heard along the top of the hull, this time followed by a series of bumps and a shattering explosion. The lights were extinguished, and above the shattering of glass was heard the hiss of escaping air and the drip of water. Examination of the machinery showed that both engines and one propelling motor were damaged and that there were many leaks in the compressed air system which raised the air pressure within the hull to a dangerous point. The lieutenant in command called a conference and it was decided to surface the ship, and if necessary to fight to the last. On reaching the surface and equalising the air pressure, an attempt was made to crawl away with one propelling motor. The periscope had been smashed and the wireless gear destroyed, but the engineers set out to effect what repairs they could. Three hours after they had surfaced the engineers reported that the starboard engine was ready for use and two hours later the port engine was also ready. The wireless installation was made to work again by the wireless operator and it was then possible to send a message warning other submarines and a call to the base for help. The latter brought destroyers, and enemy aircraft, which had twice passed near to the submarine but had not seen it, were engaged and driven off. The submarine was able to return to her base in due course, after involuntarily undergoing trials which had tested to the full her design, construction, and workmanship, and the indomitable courage and resource of her officers and crew.

K

Scottish Locomotive Experiences

By E. H. LIVESAY

No. IV.—L.N.E.R. EDINBURGH–ABERDEEN TRAINS, "V2" CLASS ENGINES

(*Continued from page 344, Oct. 6th*)

DURING the past year I have travelled upwards of 10,000 miles on all sorts and conditions of locomotives, in North America and England—which includes Scotland, though I expect this remark will get me into trouble! Their performances have shown considerable diversity, as can easily be imagined, and have ranged from very good down to, in one or two cases only, definitely bad. These disappointments I do not intend saying anything about. It will be realised that I cannot always say what I should like in these articles; it might be undiplomatic, or even definitely unkind. Sometimes I notice or hear things during these locomotive excursions that I am sure would interest others, but they are apt to be in the nature of State secrets, and then I cannot write anything about them. However, I can safely claim that I always try to tell the truth, as I see it, though it may not always be the whole truth. I dislike even "toning things down," and much prefer to say what I think. The following account, dealing with the L.N.E.R. "V2's," will give me full scope to indulge in this dangerous inclination.

Ever since making contact with the "V2's," I have looked forward to writing about them, my only concern being that I might fail to do justice to one of them, as a particular representative of the class roused my enthusiasm to an unusually high point. In one important respect I have no hesitation in putting this engine at the top of the list of all the scores of different types I have travelled on during the past year. I have tried to keep superlatives out of my narratives, but I shall give up the attempt in this article, because they are really called for. My experience with the "V2's" was as unique as it was unexpected, and no doubt it impressed me all the more on that account. I had not anticipated finding anything very out of the ordinary in a 2–6–2 type engine, yet I did. One of the class came right out of the ruck, into the lead, from which position none is likely to dislodge it—it is impossible to improve on perfection.

In a previous article I said that one of the things which made my Scottish experiences so interesting was the fact that they involved making acquaintance with types of locomotives previously strange to me. The 2–8–2 "Mikados" were a case in point, and now I come to another unusual class, the L.N.E.R. "V2's" with the 2–6–2 "Prairie" wheel classification. A common qualification can be applied to both designs; there were "2–8–2" engines in England before the "P2's," and "2–6–2's" before the "V2's," but they were tank or goods engines used for appropriate work, whereas their successors were built for fast passenger traffic.

The 2–6–2 type was developed first in America, which explains the designation "Prairie." It was the next logical step in advance from the 2–6–0, when the fire-box of the latter reached the limit of permissible size. It had been, perforce, long and narrow, but the adoption of a trailing truck removed many restrictions on both boiler and fire-box, allowing the latter to spread out behind the driving wheels, between which it had previously been cribbed, cabined, and confined. A great increase in boiler power resulted, and six-coupled wheels could be retained, yet at the same time the addition of a truck under the fire-box, one already being in position at the front end, gave the engine a capacity for fast and steady running to an extent beyond the scope of a 2–6–0. This is a brief explanation of how and why the 2–6–2 type came about, and shows that the placing of a truck at the rear was of considerable importance. The type had an immense vogue in America, and is still to be found there in considerable numbers, though train weights having increased so enormously it has latterly been displaced to a large extent by more powerful machines. In England it has not been so popular, for reasons quite unconnected with the type itself, and until recently it was only to be found in the shape of goods and tank engines. The "V2's" have at last broken new ground, as they were built for fast passenger service, and have shown themselves perfectly capable of doing it.

In the last article rather fuller details than usual were given of the "P2's," because they were of a type that had not been described before in these sketches, and for the same reason most of the chief dimensions of the "V2's" are here presented.

There is no need to give an outline drawing, as the "V2's" can be looked on roughly as shortened "P2's," which were dealt with in the last article, a drawing of them being appended then.

"*V2*" *Class, 2–6–2 Express Engines*

Cylinders (three)		18½in. by 26in.
Motion		Walschaerts-Gresley
Valves:		
Diameter		9in.
Maximum travel		5⅝in.
Steam lap, outside cylinders		1⅛in.
Steam lap, inside cylinder		1 11/16in.
Exhaust lap		Nil
Maximum cut-off		65 per cent.
Wheels:		
Driving		6ft. 2in.
Leading		3ft. 2in.
Trailing		3ft. 8in.
Boiler:		
Diameter, front		5ft. 9 3/16in.
Diameter, back		6ft. 5in.
Length between tube plates		17ft.
Heating surface:	Tubes	1211·57 sq. ft.
	Flues	1004·5 sq. ft.
	Fire-box	215·0 sq. ft.
	Superheater	679·67 sq. ft.
	Total	3110·74 sq. ft.
Fire-box:	Height of crown sheet above foundation ring, front	6ft. 8 3/16in.
	Ditto, back	6ft. 0 5/16in.
	Length at top	7ft. 11⅛in.
	Width at centre line	5ft. 4⅛in.
	Grate length	5ft. 11in.
	Grate width	6ft. 11⅛in.
	Grate area	41·25 sq. ft.
Steam pressure		220 lb.
Tractive effort at 85 per cent. boiler pressure		33,730 lb.
Wheel base:		
Driving		15ft. 6in.
Engine		33ft. 8in.
Weight:		
Leading wheels		11 tons
Driving wheels		65 tons 12 cwt.
Trailing wheels		16 tons 10 cwt.
Total: Engine		93 tons 2 cwt.
Tender		51 tons
Coal		7·5 tons
Water		4200 gallons
Factor of adhesion		4·3

Chronologically, my trips with the "V2's" did not follow immediately after those with the "P2's," but I am making them do so in this series, because they were carried out partly over the same metals, and readers will only have to refer to the "P2" article in THE ENGINEER of October 6th for a description of the Edinburgh-Dundee section of it. From Dundee northward they were over a route not yet touched, so I will give a few particulars of it first, before describing the runs themselves.

The Edinburgh-Dundee line comprises 59 miles of heavy going, with three "peaks," nine speed restrictions, and almost incessant curvature. Continuing north from Dundee, there are first of all 16 miles of level track to just beyond Elliott Junction, where steep gradients begin, and carry on right through the 55·5 miles into Aberdeen. It is an even harder stretch north than south of Dundee, and for 2 miles between Usan Box and Montrose it is single track. The last 38 miles from Kinnaber Junction—where there is a 15 m.p.h. speed restriction—to Aberdeen are over L.M.S.R. metals, which explains why, in the famous 1895 race to Aberdeen, the tussle really ended at Kinnaber Junction, as whichever one of the rivals reached there first automatically arrived first at Aberdeen. There are two other speed restrictions, one of 15 m.p.h. through Camperdown Junction, just outside Dundee, and the other of 25 m.p.h. at St. Vigean's Junction. Scenically, the Dundee-Aberdeen section is very attractive, as not only does most of it run through fine farming country, but it is often within sight and smell of the sea on one side and in view of the Grampians on the other. It is not quite so trying as the Glasgow-Mallaig line, but is a very good runner-up.

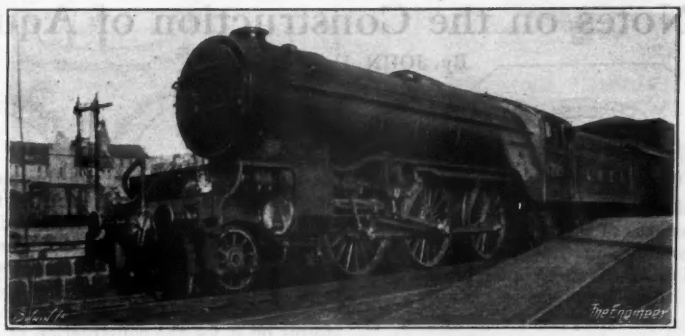
The first trip on a "V2" was made with "No. 4775," the train being the 1.9 p.m. from Edinburgh (Waverley) to Dundee, and the load 260 tons gross as far as Thornton, where it was augmented to 355 tons gross; the crew were Messrs. Kirkcaldy and Japp. Being a stopping train, a good opportunity was given the engine to show its ability at quick get away, and fast running between stations, though, as the load was so moderate, it was really not much of a test. No Hasler apparatus was fitted, so it follows that all the figures given are from personal observation. The cut-off at starting from Edinburgh was 20 per cent., the steam chest gauge showing 145 lb., boiler pressure 190 lb., with the regulator two-thirds open. Things would have been different had the load been heavier. Dalmeny was passed at 1.24 p.m., 9 miles in 15 min.—the reader will find the gradients, restrictions, and so forth, in last week's article on the "P2's"—and the Forth Bridge was crossed at 35 m.p.h. The Inverkeithing stop was made at 1.30 p.m., and the re-start, one minute late, due to extra station work, at 1.33 p.m., the 1 in 94 gradient following being taken with 25 per cent. cut-off. By this time I had begun to notice good riding qualities; there was some easy rolling, but nothing violent or sudden, about what I had expected. The weather so far had been dull and dry, but by the time Kirkcaldy was reached it was raining. Thornton, 31 miles in 65 min., involved station duties, which included the addition of three coaches, bringing the load up to 355 tons gross; it was left at 2.20 p.m., two minutes late. On the steep climb through Markinch to Lochmuir Box the cut-off was 30–35 per cent.; down the opposing Falkland bank the speed rose to 65 m.p.h., during which I recorded the action as good, and the working as quite unobtrusive. It was drizzling at the Leuchars re-start, and a little slipping occurred on the 1 in 100 climb just outside, this being taken at first with 35 per cent. cut-off, soon shortened to 30 per cent., with nearly full regulator. Dundee was reached at 3.10 p.m., one minute having been dropped in 59 miles, which included twelve stops and nine speed restrictions. The average speed was 29¼ m.p.h. I admit there is nothing very striking about this, but booked time had to be kept, and there were so many stops and restrictions that the engine never had a chance to show its powers. I was pleased with everything about the engine and with its operation, but there was nothing extraordinary about it—that was to show up after leaving Dundee, on another engine of the same class, "No. 4775" going off there. Coming events did not cast their shadows before—I knew nothing of the treat that was in store for me. At the shed I looked over the engine closely; the cab and its arrangements are identical with the "A4's" and "P2's" and are excellent, as has already been stressed. There is no streamlining, and with short cut-off running, into a head wind, steam showed an inclination to blow down. The motion is all light and fluted; ball-bearing big ends are fitted to the excentric rods. It is really an "A4" with a slightly shorter boiler; standardisation is a leading feature of the latest L.N.E.R. practice.

The journey was continued on the 6.26 p.m. train to Aberdeen, with "No. 4793," in charge of Driver Balsillie and Fireman Gamnack, the load being 320 tons gross. It was a perfect evening, the Firth of Tay sparkling in the sunshine, the Inchcape Rock standing out clearly, bringing to my mind the immortal poem of the Bell, and the pious Abbot of Aberbrothock. After the 15 m.p.h. restriction at Camperdown, there were stops at Broughton Ferry, Monifieth, Carnoustie, and Abroath, reached at 7.1 p.m. Except immediately on leaving Dundee, and entering Arbroath, it is a dead level stretch, the distance between the two towns being 17 miles, covered in 35 min. At starting the cut-off was 25 per cent.; in between times it was 18 per cent.

The reader is probably wondering when the superlatives are coming, and what they are to be applied to. Not to the average speed, evidently—to the riding. It is that which proved something altogether out of the ordinary. Directly we got under way at Dundee I noticed it was quite different from that of any engine I had previously been on, and as we ran along the straight level stretch to Arbroath, between golf links and rifle ranges, my surprise and interest increased. "No. 4793" was unusually steady; there was no "tail wagging" whatever, only a little easy rolling, and no nosing; whatever she did was quite unobtrusive. I find I noted down here: "Riding *very* good—only six weeks out of shops." It had evidently induced questions early, and my curiosity was already aroused.

Ten thousand miles on the footplate in a year, though a considerable distance, does not entitle me to lay down the law about locomotives, and certainly I am not going to attempt it. But when it has been done on half a hundred different classes of engine, from a 350-ton 2–10–4 down to a 0–4–2, it does enable me to claim some experience of how the average locomotive behaves—and can misbehave—under varying conditions. I have been on some that were very good; on others that were bad, and on one that was simply

atrocious, and I can assure the reader that there is a vast gulf between the two extremes. The difference between a comfortable car and a springless dump wagon is no greater. So when I note down that the riding of an engine is "*very* good," I mean that it is just that; it is a pleasure to be on it. "Very bad" means that the fireman exhibits bruises, the result of being flung against the side of the cab—I have been on that sort of engine, too. A locomotive can be exactly like the little girl, who, "when she was good, she was very, very good; and when she was bad, she was horrid." "No. 4793" was very, very good; I could not imagine her under any circumstances being horrid. Still, these first laudatory notes were made on a straight track; I thought things might possibly be different when we got on to the curves beyond Arbroath; I had better wait for them before coming to conclusions. Meanwhile, I was making my notes with a pad on my knee, a thing I have rarely, if ever, been able to



L.N.E.R.—V2 CLASS "PRAIRIE" ENGINE No. 4793

do on other engines. It is generally necessary for me to stand up and get some spring in my knees, or my notes are almost indecipherable. This was quite unnecessary on "No. 4793's" footplate; the writing is—well, not much worse than mine generally is.

Arbroath to Montrose includes 14 miles of heavy gradients, and plentiful curvature; it is a complete contrast to the level stretch from Dundee that precedes it. Passing through the 25 m.p.h. restriction at St. Vigean's Junction, the distance was covered in 20 min., arrival being 1 min. early, and the average speed 41 m.p.h. The speed fluctuated a good deal; curves were often sharp, and gradients were as steep as 1 in 88. I find the following note of this length—"*Superlatively* good riding—at 70 m.p.h., between Inverkeillor and Lunan Bay, round considerable curvature, stood oil-can on floor—never fell over." This, then, is where the superlatives begin, and they are fully justified. That is what was done, a thing I doubt the possibility of doing on any other engine I have ever ridden in England—or elsewhere, for that matter. The oil-can was of the long-spouted type, commonly used on locomotives, about 18in. in length, and stands, if I remember rightly, on a 3½in. base. It remained at attention on the floor of the cab indefinitely, while "No. 4793" took straights and bends at speeds up to 70 m.p.h. When Gamnack wanted to tend the fire, I removed the can, then I would replace it. It seemed impossible that anything could be better than this; but to get confirmation, I asked the crew: "You have had years of experience; surely this is altogether exceptional; have you ever known anything to beat it?" They said no, they never had. So I sat in the comfortable bucket seat, and watched the curves sweep towards me, at first instinctively awaiting the usual entering lurch, only gradually realising that there was not going to be one with this extraordinary engine. And there was not. But I will turn to a few other things now. I can—and shall—return to this matter of fine riding later.

Montrose, left at 7.21 p.m., showed that we had gained a minute. There follows a steep 4-mile climb to Kinnaber Junction, through a 15 m.p.h. restriction, with stretches of 1 in 100, 90, and 88. The cut-off is noted as having been 18 per cent., s.c.p. 200 lb., b.p. 210 lb., so evidently the regulator was full open; 18 per cent. c.o. with a 325-ton train on 1 in 88 seems rather exceptional, but is no doubt correct; I can believe anything of "No. 4793." It was in a class by itself. I omitted to mention that from Usan Box to Montrose, 2 miles, which is single track, the Manson tablet-exchange apparatus was employed. The tablet, in a leather pouch, is caught in a pair of jaws swung out from the cab side, a more scientific arrangement than the fireman's outstretched arm aimed at a loop. L.M.S.R. metals are entered upon at Kinnaber, passed slow at 7.29 p.m., and then there is heavy going, mostly uphill, to the "peak" of the whole run at Drumlithie. Fordoun, at the foot of the final 5-mile climb, was passed at 70 m.p.h.; incidentally, I noticed here the neat and thorough farming methods that are carried on in Scotland on somewhat light soil. Or could it have been that the perfection of "No. 4793" had so taken hold of me that I saw it, by association, everywhere? It is noted down, anyway. Over the Drumlithie "peak," it was then steeply down at 70–75 m.p.h. to Stonehaven, the next stop, reached at 7.56 p.m., another minute having been gained. Here I will refer once more to the "oil-can oscillation meter," from which readings were taken at high speed all the way down to Stonehaven. Considering that an even more delicate instrument was needed to gauge the perfect action, an empty whisky flask was placed beside the can on the floor—(no, we had not—tea!). This flask was only about 1½in. wide, and though it was standing lengthwise it remained as vertical as the oil-can. "They stood in beauty side by side," unaffected by curvature or speed. I find another entry in my pad covering this section: "Riding *superlative*—curves entered with an easy grace simply delightful." These entries were all made on the spot, so a subsequent overheated imagination cannot enter into the matter, or colour my judgment. It *was* superlative. The 24·5 miles from Montrose to Stonehaven, which include the very heavy 18 miles to the Drumlithie "peak," were covered in 33 min., an average of 32·7 m.p.h., and take in the 15 m.p.h. Kinnaber restriction.

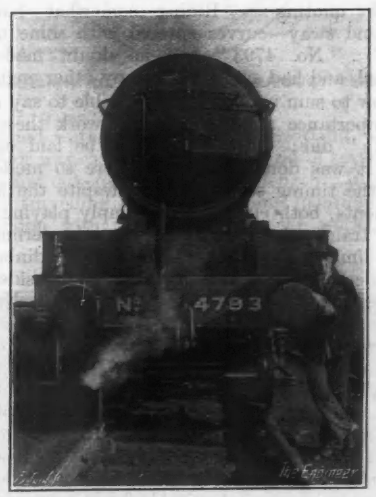
From Stonehaven into Aberdeen there are 16 miles of very heavy gradients and curvature, the last 7 miles falling steeply from the peak near Portlethen. The memory of it that remains with me is of "No. 4793," after taking the steep upward stretches on 25 per cent c.o., with fully open regulator, running easily down the opposite side, swinging round the bends in her inimitable style, while my attention was about equally divided between her and the sea on my right, turning from blue to slate grey under the setting sun. I noticed a little trawler, wending her way homeward, with a thin line of smoke trailing away behind her; like us, she was making for Aberdeen. But we got there first. I remember the sun, by this time very low, touching the grey stone buildings of the Granite City with gold, and "No. 4793" sweeping into the last long curve nearing Aberdeen at 45–50 m.p.h., rounding it exactly like a racing car taking the banking at Brooklands, and coming to a stand in the station at 8.19 p.m., 1 min. ahead of time; 71·5 miles from Dundee in 113 min., speed 37·8 m.p.h. I got down to stretch my legs, and to take an admiring look at the engine that had impressed me so much, saying to the crew: "That is the most perfect running machine I have ever been on!" They smiled, and Balsillie said: "Aye, she's no' sae bad!" The pitiful poverty of the Scots language—"no' sae bad!" She was wonderful. I felt a glow come over me when I looked at her, and I feel the same warmth now when I write about her!

Wanting to put off saying "Good-night" to "No. 4793" as long as possible, I went round to the shed with her, thinking, too, that I might be given some explanation of things there. Beyond the fact that the engine had only been out of the shops six weeks, and that all the class were good, I could get no definite data to account for the exceptional performance. This does not go far enough; there must surely be other reasons, but what, I know not. I have been on many engines that were in first-class shape, but not one of them ran like "No. 4793," or came near it. It is a mystery.

In the course of a fairly long and partly misspent life, I have noticed that one seldom gets anything worth having without asking for it. I wanted "No. 4793" to take me back to Dundee next morning; I felt that any other engine would only be in the nature of an anti-climax. So, taking the bull by the horns, I asked, and my pleadings received a sympathetic hearing. "No. 4793" was promised for the 9 a.m. train, much to my gratification. I had not seen nearly enough of this engine.

The weather next day turned out fine, making photography possible; the results are seen on this page. The front view gives point to my animadversions on attenuated chimneys, and shows why steam can sometimes blow down over the cab. There is actually a chimney; if the reader looks carefully at the other view he may find it. In this connection the visit of the "Royal Scot" to Vancouver comes to mind. If you cut a couple of inches off the chimneys of that class there would be nothing left but the hole. I was standing close in front of the visitor, when a Canadian queried: "Say, where's the smoke-stack?" "In the usual place," I replied. "Step back 50 yards and you'll see it." He did so; returning, he exclaimed: "Well! That's a hell of a note! The farther you get away from this engine the more you see of it. I guess I'll have to go outside the Yard to see everything!" And off he went—he evidently wanted a good view of it, as it was the last I saw of him.

The train was light, 270 tons gross; Driver Morrison and Fireman Angus Forbes were in the cab. It left on time, at 9 a.m., and on the steep 1 in 96 rise to Ferryhill the cut-off was 35 per cent., s.c.p. 175 lb., b.p. 210 lb.; after this it was shortened to 18 per cent., at which it remained up



FRONT END OF ENGINE

the heavy 7·5 miles to the peak near Portlethen, passed at 9.13 a.m., speed 40 m.p.h. It became 15 per cent. then, but on the climb through Stonehaven to Drumlithie, 18 per cent. was again the figure; afterwards it was back at 15 per cent. right through to the first stop at Montrose, reached at 9.48 a.m., one minute early. The speed was high, 70 m.p.h. being attained several times. I was just as impressed with the engine's perfect action as I had been the day before. My notes say: "... Stonehaven passed at 70 m.p.h.—round successive bends and over switches with scarcely a roll or lurch—*perfect* riding. Takes curves, even reverse, beautifully—no need to stand up to write." Down from the Drumlithie peak, through Fordoun and Lawrencekirk, the speed again reached 70 m.p.h. past Marykirk. We had got away from rocks and cuttings here; the country had opened right out into rolling farm land, and the Grampians lay, a blue-grey wall, to the right, in the distance. Kinnaber Junction, where L.N.E.R. metals are reached, was passed at 13 m.p.h., and we came to a stand in Montrose at 9.48 a.m., a minute early; 40·5 miles from Aberdeen in 48 min., speed 50·6 m.p.h., the highest I recorded on any part of the Aberdeen route. I had jotted down that apparently leading and trailing trucks alike were doing their work perfectly, as "... both ends of the engine equally steady" is on the pad. It has seemed to me that unsteadiness in L.N.E.R.

engines has generally come from the trailing Cartazzi truck, when there is any wear in the guides, or axle-box top, as I mentioned in the "Royal Scot" article (The Engineer, April 7th). "No. 4793's" truck mechanism was in perfect shape, and its action was as good as could be wished.

Leaving Montrose at 9.50 a.m., there are 2 miles of single track to Usan Box, mostly at 1 in 88, and a couple of miles more steep climb following; over the peak, 15 miles of up-and-down brought us into Arbroath, through the St. Vigean's 25 m.p.h. restriction, to stop at 10.8 a.m., two minutes early. 14 miles in 18 min., 46⅔ m.p.h. Very good for such a hard stretch. I must again refer to short chimneys here, and to another little trouble they can give rise to—down-draught. When the regulator was shut for the Abroath stop the blower was not put on, and at that moment, a gust of wind came down on "No. 4793," causing a vicious sheet of flame to pour out of the fire-door. Fortunately, nobody happened to be in front of it, or serious burns might have resulted, and eyelashes and eyebrows would certainly have frizzled up. Along the level straight into Dundee, speed once more reached 70 m.p.h., cut to 15 m.p.h. for a P.W.S. through Camperdown Junction. The cut-off remained set at 15 per cent. and the engine's running was as steady as a top. Dundee was reached at 10.32 a.m., dead on time, the average speed from Arbroath being 46·4 m.p.h., the 17 miles having been covered in 22 min. The last entry on my pad—the writing is a little shaky; we must have been doing over 70—reads: "Everything perfect—impossible to find any fault." And on that note, a very fitting one for the story of "No. 4793," this account of her performance ends.

I continued to Edinburgh on an "A3 Pacific," No. 2506, "Salmon Trout," but that engine had better come into an article dealing with its class; this one concerns the "V2's." I think I will just give the note I find on my pad, which refers to "Salmon Trout." "Riding rough compared with 2–6–2." Rather fishy! And there is another one worth quoting: "Riding somewhat harsh—rear-end sway—curves entered with some objection." "No. 4793" had no doubt made me critical, and had spoilt me for any other engine.

Now to sum up. It is not possible to say much of importance about the actual work these two "V2's" did; chief stress must be laid on the way it was done. The loads were so moderate, and the timing so easy, that despite the heavy gradients, both engines were simply playing with their trains. I do not know what the permissible load limit for the class is over the Edinburgh–Aberdeen section, but it must be considerably above what was handled on these runs. Neither engine was extended in any way. The behaviour of both was good, and if all representatives of the class are even equal to "No. 4775," it would prove them to be well-designed, capable machines. But "No. 4793's" running was so exceptional that a good deal could be written around it, and about engines of that wheel formation. I believe it used to be considered an axiom that a single-axle leading truck was not suitable for high speeds, and that a bogie was essential. The "V2s" prove this to be, at any rate, exaggerated. If 2–6–2's can take curvature in the way "No. 4793" did, speeds up to 90 m.p.h. on a good track should be easily within their safe limit. Might not the addition of a little extra weight on the leading truck, and possibly a slight stiffening of the control springs, make assurance doubly sure? The "V2's" only carry 11 tons on the front axle, which is not, after all, a very big load. Where could the extra weight come from? A slightly longer boiler would supply it; the "V2's" tube plates are only 17ft. apart. No weight would then have to come off the coupled axles. However, I am not setting up in business as a locomotive designer; I must content myself with suggesting improvements to other people's efforts!

I have said a good deal about riding qualities; it may be asked, are these really so important? I am inclined to think so. A bad riding engine is hard on itself, and on the track, and can shake itself to pieces, with resulting high cost of upkeep, and wear and tear on the permanent way. A good riding engine is surely worth striving for, and merits attention being drawn to it, and credit given in the interests of efficiency and design.

Until I made these "V2" runs I had not come out into the open and stated definitely which class of engine, so far as my limited experience went, had proved the best riding. I have been loath to do it; in fact, I did think perhaps it would be best not to do it at all, in case it might cause heart burning! But the temptation has proved too strong, and in this article I have, at all events, made no secret of which engine individually has carried off the palm. So I may as well go the whole hog and confess my class preference, too. Out of all the scores of types and classes of locomotives of which so far I have had experience in North America and over here, I think the L.M.S.R. "Coronations" come first in this regard, with the L.N.E.R. "A4's" and the C.P.R. "2700" 4–6–4's bracketed a close second. I never expected to find them beaten, but "No. 4793" did it. Naturally, a great deal depends on the condition an engine is in; this one had only been a few weeks out of the shops. The "A4's" were excellent, but, as I said in the "Royal Scot" article (The Engineer, April 7th), their Achilles' heel seemed to be the rear Cartazzi truck, when wear had developed in the guides. "No. 4793" had a similar truck, but it was in perfect condition, and its action was unexceptionable. My timid suggestion seems to have been right, however, as I understand that attention is now being paid to this feature. I do not claim the credit for it! It was the only criticism I could put forward in connection with the fine "A4's," and I excuse myself for making it in the same way the housemaid in "Mr. Midshipman Easy" did for her accidental baby—it was only a very little one.

From every point of view, then, my experiences with the "V2's" were favourable, and I need hardly say that everyone concerned in them, from officials to enginemen, was courteous and helpful. When I come to Scotland again, I shall make a point of renewing my acquaintance with "No. 4793"; I think the journey will be worth while even if only with that end in view!

(To be continued)

Some Notes on the Construction of Aqueducts

By JOHN D. WATSON

No. II

(Continued from page 346, Oct. 6th)

Low-pressure Conduits

As a general rule, one might anticipate considerable lengths of what might be classified as low-pressure conduits in the present connection, and this portion of the work again can be considered under three headings—concrete pressure pipe, closed, but non-pressure conduits, and aqueducts of continuous construction able to withstand internal pressure up to about 60ft. or 70ft. In so far as pipe is concerned, it comes in for some consideration later on under the heading of "Concrete Pressure Pipe," though in diameters up to about 6ft. or so, concrete pipe able to operate under some pressure with simple forms of pressure joint, such as the Stanton Cornelius, is to be associated with the every-day productions of the

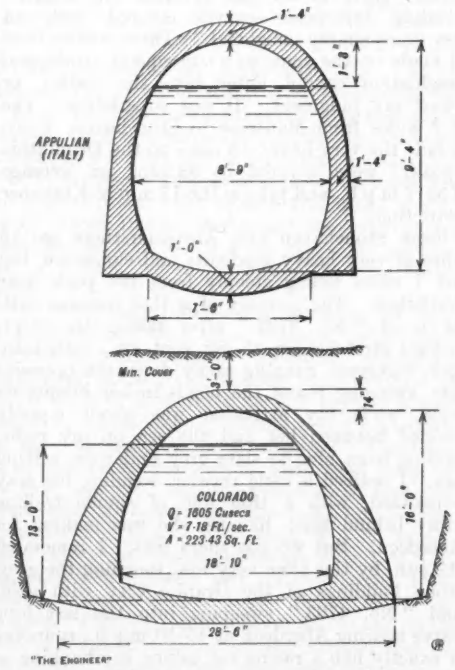


FIG. 8—EXAMPLE OF CLOSED CONDUITS

Stanton Company under the Hume process, though in the construction of aqueducts, pressure conduits, whether formed continuous or of specially made pipe, 12ft. or more in diameter, are not uncommon, and one also has to consider parts of the line where non-pressure conduit would serve the purpose. In Fig. 8, for instance, are shown two examples. The upper diagram is a section of cut-and-cover work on the Appulian aqueduct in Italy, completed some years ago, while the lower one relates to the aforementioned Colorado works, designed for a discharge of 1605 cusecs in common with the open cut. It is, however, designed for a velocity of 7·18ft. per second. The water area is 223·43 square feet, r=5·10ft., and s=0·0005. The general method of construction here is to cut a trench deep enough to ensure the necessary depth of backfill cover which the arch has to be designed to carry, while the thickness of the base would depend upon the nature of the foundation and the load to be carried. Reinforcement may or may not be required for this class of work. In the case in point, but little was used. Construction is usually carried out by first forming the invert portion and then erecting collapsible metal forms on it for the construction of the arch. The general principles are illustrated in the diagrams in Fig. 9, the upper one showing the forms in position for concreting, and the lower one the inner form collapsed so that it can be carried forward on a carriage to the next section. Supported on the blocks A, the inner form is positioned from the outer one by bolts B, tapered and polished for ease of removal after the concrete is poured. The forms are constructed of steel plates on the ribs C, the inner one being in hinged sections. After the inside forms have been slacked by the removal of the stiff connections at the hinges D and E, the segments D E are rotated. The cantilever beam of the carriage has now been advanced, and by means of temporary arms attached at F, the main ribs are drawn in. Collapsible forms are applied

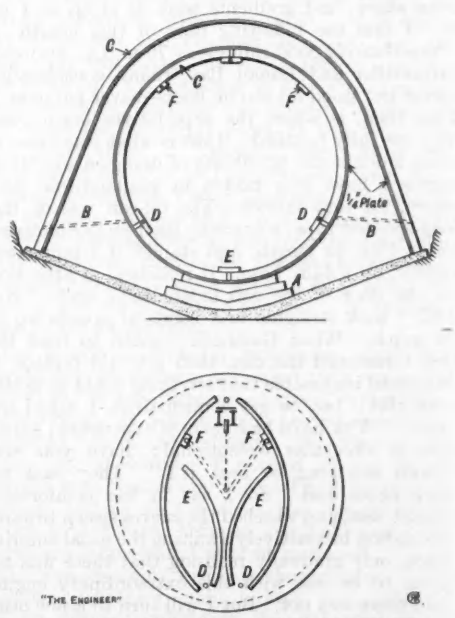


FIG. 9—COLLAPSIBLE FORMS FOR AQUEDUCT CONSTRUCTION

to the lining of pressure tunnels or any fully lined tunnel. Tunnel work as such has figured on recent aqueducts to a large extent, notably those in connection with the Scottish water power works, and some comparative sections are given in Fig. 10, and drawn to the same scale, indicating the use of the familiar horseshoe section, which was also adopted in the case of tunnel sections on the Appulian aqueduct. Of generally smaller section than railway tunnels, these sections of aqueducts are more notable for their length and lining, as already suggested, to enable them to operate under pressure. Otherwise, tunnel work, apart from

the employment of different methods of construction according to the nature of the ground, is the same, whether it applies to a railway, aqueduct, or sewer construction, or whatever its final purpose, and is work of a special nature. It is not necessary to go into it further here.

So far as pressure conduits in general are concerned, the decision to use steel or ferro-concrete—the former will in all probability be concrete lined in any case—must always depend upon a number of different factors, and the fact that but little work of the latter class is seen on American works in comparison with the extent it has been used in Britain and Europe, is no indication of the general superiority or ultimate economy of steel pipe. The

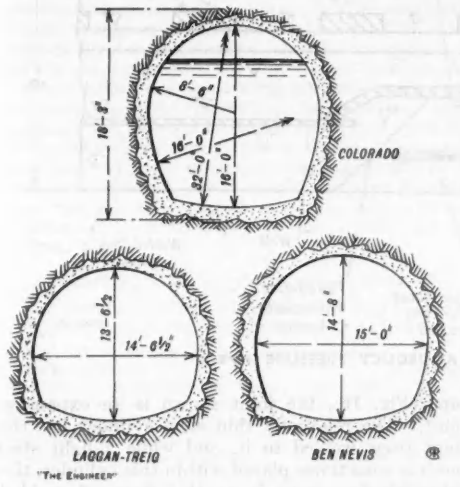


FIG. 10—SECTIONS OF AQUEDUCTS IN TUNNEL

economy of concrete appealed to the engineers of the Drac-Romanche power works in connection with the Chambon barrage, and designed for a pressure of 46ft., the form of pressure conduit shown in Fig. 13 was adopted for part of the line to a power station near Grenoble in 1925, though similar construction was actually accomplished by the designer of this work in 1899, in the form of 8000ft. of 10ft. 9in. diameter conduit working under 65ft. head on the same works. The present work is rather shorter, being about 4500ft. in length. Formed as shown in cut and cover, there are two concentric rings of reinforcing bars, close together at the bottom, but separated at the top. They vary from ¼in. to ⅞in., according to the head conditions, which vary from about 25ft. to 45ft., as stated. The longitudinals vary from ninety 0·3in. diameter bars to 135 0·37in. diameter bars, with eight supplementary bars in the 3½ft. lengths at the shoulders. The water-tight parts of the walls are 7⅞in. thick.

The pre-formed rings were placed in position on the invert by means of a moving stage, the section of the invert then laid, and the sides and top formed by movable internal and external forms, and by

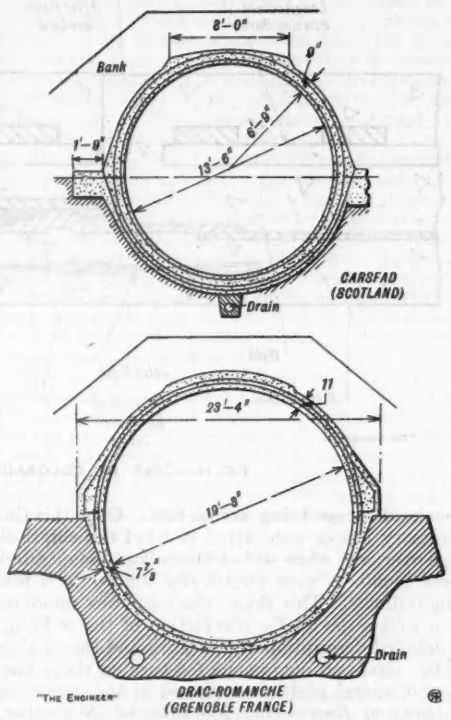


FIG. 13—PRESSURE AQUEDUCTS

means of a concrete mixer erected on a gantry running astride the pipe, lengths of about 40ft. were poured. The internal form used here was supported on wheels on rails already set in the invert and after the lowering of the upper part by means of jacks, the form was moved forward, the casting of each section being done in the afternoon following the setting up of the form moved from the previous section in the morning. After covering the finished work with earth to relieve any temperature stress, the joints between the sections were vee-grooved internally, and rammed up with rich cement mortar, and after being allowed to harden out, this conduit, except

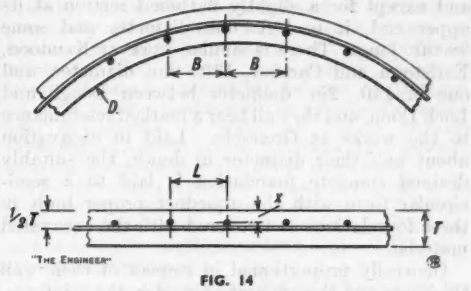


FIG. 14

for a few small initial leaks, proved well up to its duty. Similar work is to be seen on the Queen Mary reservoir aqueduct of the Metropolitan Water Board, and the Tongland aqueduct of the recently

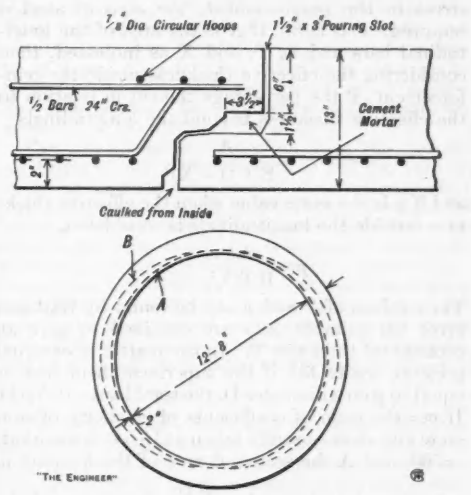
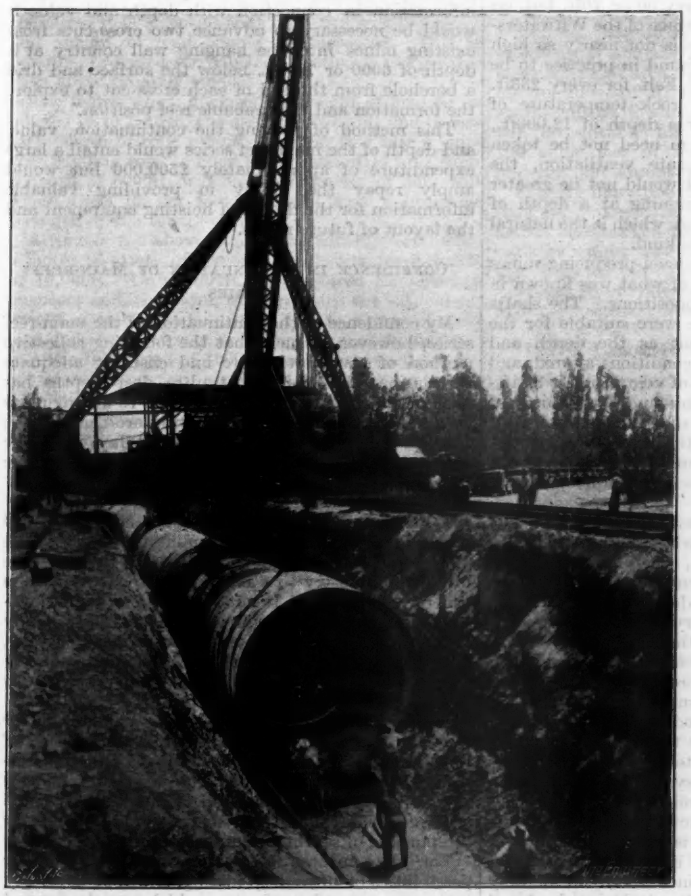


FIG. 15—DESIGN OF COLORADO AQUEDUCT PRESSURE PIPE

completed water power works in Scotland, where the work was carried out with the aid of travelling inside and outside forms, 40ft. in length. In place of the travelling concrete machine mentioned in connection with the Drac-Romanche works, the



FIGS. 11 AND 12—CONCRETE PRESSURE PIPE FOR COLORADO AQUEDUCT

concrete here was very expeditiously handled by a 30-cwt. crane erected on the top of the outside form. It lifted the concrete buckets from the side and tipped them into the top of the form through the traveller. Each 50ft. length required the deposition of about 100 cubic yards of concrete, and except for a slightly flattened section at its upper end, it is 18ft. 6in. diameter and some 3800ft. long. There is similar work at Kendoon, Earlstoun and Carsfad, 13ft. 6in. diameter, and one of 14ft. 2in. diameter between Deugh and Loch Doon, and they all bear a marked resemblance to the works at Grenoble. Laid in excavation about half their diameter in depth, the suitably drained concrete foundation is laid to a semi-circular form with the aqueduct proper built in these foundations and covered with the excavated material.

Generally proportioned in respect of their wall thickness and the amount of steel in the reinforcement by trial and error, these values can be arrived at in a relatively simple manner by reference to the diagram in Fig. 14. That is considering any strip of a width B on a diameter D, if P is the unit pressure on the sides and S the safe unit stress in the reinforcement, the area of steel a required=P D B/S. If A is the area of the longitudinal bars and L, T, and X as indicated, then considering the effective thickness inside the reinforcement, P the percentage thereof in relation to the effective thickness beyond the longitudinals

$$=\frac{A}{B\,T\,(1-X)},$$

and if p is the same value when the effective thickness outside the longitudinals is considered,

$$p=\frac{A}{B\,T\,X}.$$

Then values of P and p can be found by trial and error till suitable ones are obtained to give an economical thickness T. In the matter of external pressure under fill, if the superincumbent load is equal to p on a diameter D, the total load=$0{\cdot}5\,p$ D. If m=the ratio of coefficients of elasticity of concrete and steel—usually taken at 15—C, a constant, =500, and A the sectional area of the hooping in any given length L, then $\frac{p\,D}{2}=C\,[a+(m-1)\,A]$, when a=L T. Knowing T as A=p L T, $p=\frac{A}{L\,T}$. Therefore, $0{\cdot}5\,p$ D=500 L T $(1+14\,p)$, from which a value of T can be deduced, and compared with what has been tentatively selected.

Concrete Pressure Pipe

Whether the pressure portion of an aqueduct when not constructed of steel (or wood stave) pipe is better formed of individual lengths of pipe than as continuous construction on the lines alluded to, is probably a matter which would be dictated more by local considerations than anything else, in the same way as in the construction of siphons, for instance, or sections in bad ground, cast iron segment construction may be resorted to. Having in view the relatively large diameter of pipe required possibly 10ft. or 12ft., and a wall thickness of anything up to 12in., the weight of even short sections, as will be noted presently, may be over 40 tons, so that the transport of such sections and their placing in position may be much more difficult than the setting up of forms and the mixing and pouring plant to be associated with continuous construction. Up to diameters of about 6ft., concrete pipe with an ability to stand low pressure is essentially a factory operation, but the pipes shown in the photographic view in Fig. 11, and of which some details are given in the diagram in Fig. 15, are over 12ft. in the bore and with a wall thickness of 13in. The 12ft. lengths in which they were cast for the Colorado works weighed 43 tons, and some of them were used as shown in Fig. 12 for the siphons on this line. They are designed to carry 750 cusecs at 7·02ft. per second under flow conditions of A=106·90, n=0·012, r=2·92, and s=0·00077. The fabrication of such pipe is a contracting job calling for the equipment being set up more or less locally. Cast vertically, while the pouring in the moulds is not a more difficult operation than would be associated with any other heavy precast work, the fabrication of the reinforcement is not a job to be undertaken lightly. The sectional diagram indicates that in the present case it is in two rings A and B. It varies in amount from 1·8 to 2·8 square inches per lineal foot, depending upon both the depth of cover and the internal working pressure. The steel here is so divided that approximately one-third is placed in a circular cage, whose centre line is 2in. from the inner surface and two-thirds in a cage placed elliptically. Some of this pipe, which is 10ft. 3in. diameter, is designed to operate under higher heads, as, for instance, in the siphon sections, and it is cylinder reinforced pipe with a joint of the form shown in Fig. 16. In respect of the lighter pipe, the reinforcement is mainly of ¾in. steel wire, the skeleton cage being fabricated by winding it on a specially designed mandrel, the circular cage being wound first. Over this the necessary braces were fitted to wind the elliptical cage over, and while still on the collapsible mandrel these members were electrically welded to a few longitudinals. This done, the cage was removed to a rolling device for completion of the welding. A detailed description of this work and the casting of the pipe and equipment for turning them into the horizontal position appeared in the American publication *Engineering News-Record*, November, 1938, these operations, including internally bracing the pipes to prevent their deflection when being rolled. The trenching seen in the photographic view in Fig. 12, was mainly excavated by dragline. There are actually 9½ miles of this pipe working under an average head of 60ft. The pipe was actually designed for a pressure of 80ft.

In the matter of the heavier pressure " cylinder "

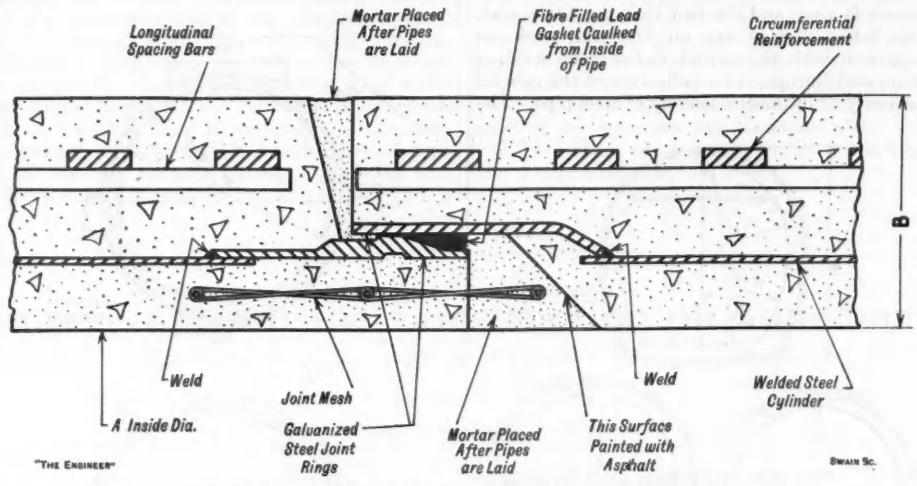


FIG. 16—JOINT IN COLORADO AQUEDUCT PRESSURE PIPE

pipe (Fig. 16), the joint shown is an expansion joint. The relatively thin steel cylinder has the joint rings welded to it, and while a light steel mesh is sometimes placed within this cylinder, the other reinforcement is in the form of welded hoops of rectangular section welded to the longitudinal spacing bars. The cylinder itself is tested for water-tightness before being placed in the moulds, and the casting is done vertically in combination with tamping and vibration.

Rand Gold Fields and their Future

No. II

(*Continued from page 347, Oct. 6th*)

Temperature Increase at Depth

THE generally accepted temperature increase with depth is 1 deg. Fah. for every 60 or 70ft. but, on account of the elevated land surface of the Witwatersrand, the temperature increase is not nearly so high as this figure and is actually found in practice to be in the neighbourhood of 1 deg. Fah. for every 233ft. This figure would indicate a rock temperature of 117 deg. Fah. when mining at a depth of 12,000ft., but this feature of the problem need not be taken seriously because, with adequate ventilation, the rock temperatures encountered would not be greater than that experienced when mining at a depth of 6000ft. below the level of the sea, which is the natural horizon for the existence of mankind.

Most, if not all, of the deep-level producing mines on the Rand are an extension of what was known in the early days as out-crop propositions. The shafts which were sunk at that time were suitable for the requirements of the mine, but as the depth and temperature increased, so the conditions altered, and this led to the serious problem of ventilation. Shafts of larger dimensions were sunk and large sums of money have been spent on mechanical appliances for the purpose of improving the ventilation system, and although a certain amount of success has been achieved the system would be unsuitable for ultra deep mining.

It will be obvious to all, that if it were economically possible to mine from open workings, there would be no ventilation problem and, therefore, the only solution to the problem of ventilation when mining at great depths, is to provide adequate shaft capacity.

The capital outlay necessary to bring a modern Witwatersrand gold mine to the production stage is anything between three and four million pounds and it takes five to six years before the mine will commence producing. This is assuming, of course, that the reef is in the neighbourhood of 5000ft. below the surface. With depths greater than this, the capital outlay would be much greater, and indeed, it is questionable if the present system of opening up new mines would be an economic proposition.

The unmined portion of the main-reef series and the value of the ore content is of course unknown, but from present indications it would appear that there is yet an area of unmined reef, considerably greater than that which has already been mined and is in course of being mined at the present time. Unfortunately, however, the major portion of the reef underlying this area is situated at a depth of probably 12,000ft., and to acquire more accurate information in connection with depth and value it would be necessary to advance two cross-cuts from existing mines into the hanging wall country at a depth of 6000 or 7000ft. below the surface and drill a borehole from the end of each cross-cut to explore the formation and the probable reef position.

This method of proving the continuation, value, and depth of the main-reef series would entail a large expenditure of approximately £500,000 but would amply repay the outlay in providing valuable information for the design of hoisting equipment and the layout of future mines.

Confidence in Continuation of Main-reef Series

My confidence in the continuation of the main-reef series, however, is such, that the following collective method of transporting ore and ensuring adequate ventilation when mining at ultra deep depths has been prepared. It must be apparent to all engineers that the present method of hoisting ore through the inadequate shafts which are in use to-day, would be both uneconomical and impracticable for the large tonnages which must be drawn from depths considerably below 6000ft.

Without some vastly improved arrangement it will be economically impossible to mine the whole of the auriferous conglomerate and this will decrease the life of the industry to a much greater extent than is generally supposed. It must be borne in mind, however, that with the engineering technique already acquired, encouragement and sound financial backing, there is no reason why the gold mining industry should not continue to flourish as at present for several generations.

I have given this matter serious consideration for several years and I am satisfied that the solution of the problem of ultra deep mining rests in the provision of a subsidiary out-crop at approximately 6000ft. below the surface, and from which elevation a staggered line of vertical shafts would be sunk for the purpose of serving a number of mines.

For the purpose of calculating the economic possibilities of ultra deep mining, it will be necessary to assume a number of mines which may be termed a unit. The unit will contain six mines, each of

which will have a claim area equal in extent to 5000 claims, and the unit will be served by six circular shafts of 100ft. in diameter. The method employed at the present time for opening up deep mines of from 3000 to 6000ft. below the surface, is to sink two vertical shafts and as mining progresses sink further verticals from the surface until, eventually, there are five vertical shafts serving a mine with an area of 5000 claims.

It will be found as we proceed, however, that six shafts of the above dimensions will give more efficient service, provide adequate ventilation, and will cost, in the aggregate, no more than the smaller dimensioned shafts in use at the present time. It would, of course, be impossible to control the unit or six mines by the same personnel as is in vogue to-day and, therefore, it will be necessary to divide the company controlling the unit into four companies of smaller dimensions. One company will be responsible for the transport of men, material, and ore from the 6000-ft. level to the surface. Another company will supply the compressed air and control the draining system, whilst the third company will control the mining section below the 6000-ft. level, and the fourth company will be responsible for the reduction of the ore produced. Electric power would, of course, constitute another company, but as there is at present an efficient power supply company in existence which is quite capable of taking charge of the position, it is unnecessary to again refer to the subject.

Capital Requirements for Scheme

The capital requirements of the four companies to complete a unit would be approximately as follows :—

Transportation between the 6000′ level and Surface Reduction Works	£7,000,000
Shaft sinking, Equipment and Development below the 6000′ level...	7,000,000
Drainage, Ventilation and Air Power	5,000,000
Reduction Plant	6,000,000
Contingencies	5,000,000
Total	£30,000,000

The above figures would represent a capital outlay of £5,000,000 for each of the six mines, a figure which does not appear unreasonable.

The transport company would be responsible for the sinking of six circular shafts to the 6000-ft. horizon and connecting them by means of a large haulage. The necessary equipment would include six super winding engines, each capable of hoisting a rock load of 16 tons at a speed of 4000ft. per minute, and six smaller winding engines suitable for the conveyance of men and materials.

Headgears, locomotives, and track are also included in the equipment, but 50 per cent. of the cost of sinking the shafts would be a debit against the drainage and ventilation company, as most of the shaft is required for purely ventilation purposes.

Hoisting a load of 8 tons from a depth of 6000ft. has become a practice, and it is considered that under existing conditions this weight is about the maximum which should be attempted. When mining at depth greater than 6000ft., however, and hoisting large tonnages, it is essential that both the winding speed and weight of load should be increased. This is possible, provided the depth of hoisting is not greater than approximately 6000ft.

The factor which governs the weight of load to be hoisted is, of course, the strength, weight, and necessary length of rope required, and in this case a suitable winding rope to hoist a pay load of 16 tons from a depth of 6000ft. will have a diameter of 3in., will weigh 15·21 lb. per foot, and will have a breaking strength of 455 tons.

A rope of the above dimensions will support—with a factor of safety of six—its own length for a depth of 10,000ft. Only 6000ft. are required for hoisting purposes and, therefore, there remains the equivalent weight of 4000ft. to be utilised for the weight of rock load and conveyance, which is approximately 30 tons.

A winding speed of 4000ft. per minute need not be considered excessive, and in all probability a speed of 5000ft. per minute, when hoisting rock, could be attained. These speeds should be possible on account of the large shaft clearances whereby the air friction will be reduced to a minimum and, as the necessary shaft supports will be fabricated from reinforced concrete, the danger from dislocated timber in the shaft would be non-existent. The only timber which might be installed in the shaft would be for guides, if wood is used for this purpose in preference to steel.

The above winding problem has been described at probably greater length than is really necessary, but, as hoisting is a major issue in ultra deep mining, it is essential to establish that heavy loads can be raised at a much greater speed than that which is in general use to-day and this becomes necessary when hoisting large tonnages of rock from great depths.

It is unnecessary to refer to the size of the winding engine because, at the present time, rock loads of 8 tons are being hoisted from a depth of over 6000ft. and, as the pick-up load in this case is merely doubled, the size of the engine must be proportionately increased.

Shaft Sinking and Development

Shaft sinking and development for the six mines will be commenced from the 6000-ft. horizon, which may be termed the sub-outcrop, and, according to the position of the mine in relation to the dip of the auriferous layers, it will be necessary to drive two tunnels for each mine to a suitable position from which to commence mining operations. All expenditure in connection with mining and equipment below or from the sub-outcrop will be a debit against the individual mine concerned and it will be the mine's responsibility as well to provide the necessary surface requirements such as compound, hospital, shops, houses, and the recognised surface requirements.

There will be the usual number of shafts, through which the mine will deliver the ore produced to the sub-outcrop. These shafts and their equipment will be of much smaller dimensions than the surface shafts and their location will be what is considered to be most suited to the mining of the area concerned. The ore delivered on the sub-outcrop will be taken charge of by the transportation company and conveyed to the surface reduction works.

The transportation company will also be responsible for the transport of men and materials and, during an average working day, will lower and raise from the 6000-ft. level something in the neighbourhood of 50,000 to 60,000 natives as well as the European staff necessary to supervise this force. The equipment and organisation necessary for the transport of this large complement will be so arranged that the men will reach their stations with the same measure of ease and safety as they would do on any other underground transport system.

The underground water from each mine will be pumped to the sub-outcrop from which place it will be collected by the drainage company and delivered on the surface. With an adequate supply of electric power, compressed air, and fresh water supplied to the individual mine by the drainage company, the risk of failure of the supplies will be remote and the miners' responsibilities will therefore be proportionally decreased.

The drainage, ventilation, and compressed air supply company will collect all water on the sub-outcrop from the separate mines and pump it to the surface, where it will be distributed to the reduction works. It is difficult to estimate the quantity of water which will have to be pumped, but it is reasonable to assume that the natural inflow from each mine, plus the quantity of fresh water sent down for drinking, machines, and other purposes, will not be much less than 50,000,000 gallons per month, which will produce a figure of 300,000,000, or 10,000,000 gallons every twenty-four hours. In all probability this large volume of water will not be encountered in the early stages of mining, but it is essential that adequate pumping plant should be installed to meet any emergency which may arise.

The necessary equipment to deal with quantities of water such as this, will require twelve centrifugal pumps each having a capacity of 100,000 gallons per hour and designed for a static head of 3000ft. In one of the central shafts it will be necessary to cut, whilst sinking, a suitable pumping station for the purpose of accommodating six of these units. This will provide the second lift of what is generally known as stage pumping.

For the purpose of supplying the six mines with ample fresh air, the six circular shafts will have a cross-sectional area, after deducting 20 per cent. for obstructions, of 37,704 square feet. Three of the shafts will be downcast and three others upcast and will be suitable for the supply of approximately 200 cubic feet of fresh air per minute for every underground employee.

Slightly more power than the natural heat will be required to keep the large volume of air in motion, and it will be the function of the ventilation company to supply and maintain suitable apparatus for this purpose. It will also be the business of the company to provide each mine belonging to the unit with the necessary quantity of air required.

Three Large Reduction Works Required

Three large reduction works, each having a crushing capacity of 400,000 tons per month, will be required for the reduction of the ore produced by the unit. These works will be situated in different localities for the purpose of ensuring ample dumping space for the disposal of residues and waste rock. The selection of suitable sites will depend on the topographical features of the locality as the conservation of large volumes of water will be of primary importance.

The three reduction works will be divided into six sections, so that the ore from one mine will not become intermixed with the ore produced by one of the other mines belonging to the unit. This, of course, might be altered and a decision come to whereby the one reduction plant would deal with the entire output of the two mines concerned, with possible economies, if it is found possible to allocate equitably the gold output to the separate companies.

The system of milling large tonnages of ore from separate mines will create a position by which it will be possible to eliminate most of the small but essential equipment, required in the present day reduction works, and will have the effect of still further increasing the already high standard of efficiency met with on the Rand.

My calculations, which of necessity are only preliminary estimates, shows that approximately £30,000,000 is required to open up an area of this kind, and the distribution of revenue from this scheme is shown hereunder.

The yearly revenue derived from the sale of gold by the unit, assuming that the price of gold and demand remains as at present, will amount to approximately £20,000,000. Working costs will probably be in the neighbourhood of £15,000,000 practically all of which will be spent within the Union of South Africa. The interest on capital and redemption will amount to a further £4,500,000 leaving a small unexpended balance of £500,000, which is a very small margin to provide for unforeseen emergencies, to which all mining ventures throughout the world are subject and will be especially so in an undertaking of the above magnitude.

The above figures must be considered purely as an estimate and are therefore liable to adjustment. They do show, however, that ultra deep mining, excluding direct taxation, is both a practical and an economic proposition.

I have now reached the end of my address, but before concluding I should like to mention that an endeavour has been made to explain the most likely method by which the sedimentary deposits of the Rand were accumulated. There have been many theories advanced to account for their formation and I am not quite sure that I have been any more successful in finding a solution to the problem than other authors who have studied the subject, but, nevertheless, even unsatisfactory explanations may be of value, in so far that they direct attention to factors which may have been insufficiently studied and thus lead to research which may eventually increase our knowledge of the subject.

The hypothesis in connection with the possible age of the oldest sedimentary rocks and the solution of the problem by astronomical observations will, I feel sure, lead to much controversy. It must be remembered, however, that accurate information on a subject of this description is at present unobtainable and, therefore, if the suggested method of determining the age of rocks devoid of fossil remains is unacceptable, it will at least afford a sort of basis for further discussion, which may eventually lead to the true answer and, I hope, bring to those of our members and others a few pleasant hours of suggestive thought.

Gold Mines a Wasting Asset

The section which deals with the future activities of the gold mining industry is, of course, of a more practical nature. It is common knowledge that the chief source of our national income is a wasting asset and, although a small income derived from secondary industries may assist this wastage to a limited extent, it must be borne in mind that in a sparsely populated country such as ours, the demand for manufactured goods will be of a negligible quantity if the primary industry of the Witwatersrand is allowed to wane.

There are no insurmountable difficulties of which I am aware to prevent mining at depths suitable for the recovery of the whole of the auriferous conglomerate layers associated with the 'Main Reef Series' and, therefore, any information or other suggestions which will tend to confirm this assurance will be to the mutual benefit of the whole of the Union of South Africa."

While expressing interests in the statement made by Mr. Craib, none of the leasers of the mining industry approached so far have been prepared to comment on the various aspects of his paper. Attention was drawn, however, to a statement by Mr. G. Carleton Jones at the annual meeting of the Robinson Deep, Ltd., in May this year, in which he spoke of the success of air cooling in gaining additional mining depth. It was calculated, Mr. Carleton Jones said at the time, that with cooling and the present shaft system it would be possible to carry out stopping operations in the mine at a depth of about 9000ft. below the shaft collar. At present the lowest vertical depth below the shaft collar in the mine is 8500ft. Mr. Carleton Jones went on to say that it was calculated that a virgin rock temperature of 130 deg. Fah. would not be obtained until a depth of 12,800ft. was reached on the Witwatersrand, so that with suitable shafts it would appear to be physically possible to mine to at least a depth of 12,800ft. on the Witwatersrand.

New Material for Tipped Tools.—A new tungsten-titanium carbide material corresponding to the formula $W_2Ti_2C_4$ has been developed for use in tipping tools and in the manufacture of nozzles, valve seats, die inserts, etc. According to *Industrial and Engineering Chemistry* it is manufactured by heating tungsten-titanium and carbon in a bath of nickel for a prolonged period at 2000 deg. Cent. in graphite crucibles. The carbide crystals are recovered, after cooling, from the nickel bath by dissolving the latter by a primary digestion with aqua regia and other reagents. This is followed by a treatment with hydrofluoric acid in platinum dishes. The tungsten-titanium-carbide crystals are milled with cobalt, tungsten, and carbon, the mixture then being pressed to the required shape before sintering. The tools are said to have excellent resistance to shock and to cratering and are recommended for the machining of hard tough materials, which do not give a short chip.

Electric Drives in the Petroleum Industry*

IN the early days of commercial petroleum production, the resources of the known fields were far in excess of demands, and the costs of production were low. Since most of these fields have been fully developed it has become necessary to search for new deposits, the search frequently being carried into the most remote spots and even out into the foreshore of the sea. Although geologists do much valuable and indispensable work they are only able to indicate the whereabouts of formations such as may contain petroleum; and while the chemical analysis of petroleum is known, the origin and circumstances attendant upon its formation have not been definitely established. It is generally believed to be a product of the decomposition of animal fats resulting from the deposition of countless numbers of marine organisms which had existence in the cretaceous period; such deposits being subsequently overlaid by strata of later origin, and the pressure and heat generated by subterranean movement having transformed these fats into mineral oils. The form of "crude" varies considerably throughout the world, that in parts of South America varying from thin almost colourless fluid to bituminous, viscous matter too thick to pump without using a solvent. Some crudes are of paraffinic and some of naphthalenic base.

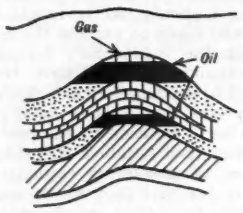


FIG. 1.—SIMPLE ANTICLINE

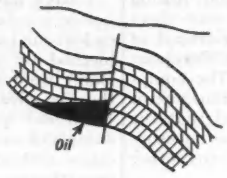


FIG. 2.—TERRACE

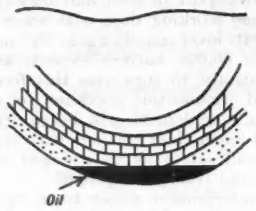


FIG. 3.—SYNCLINE

It may be of interest to give a brief description of the preliminary work which devolves upon the geological and geophysical staff before the drilling begins. Based upon the subsurface structure of the world's major fields, the anticlinal theory has been developed, this being that oil is most likely to occur at the dome or dip of a folded structure and to be contained in a sedimentary formation of sand, limestone, or sandstone, having been forced into this position by salt water which was absorbed by the sands when they were below sea level. Fig. 1 indicates a simple anticline and it will be observed that in this instance the oil is attended by a gas zone; such gas when present may be at an extremely high pressure. Figs. 2 and 3 indicate other simple typical structures where oil may be situated, and in the case of Fig. 2 the oil has been trapped by faulting or relative movement, leaving the porous oil-bearing sands blocked by a non-porous formation.

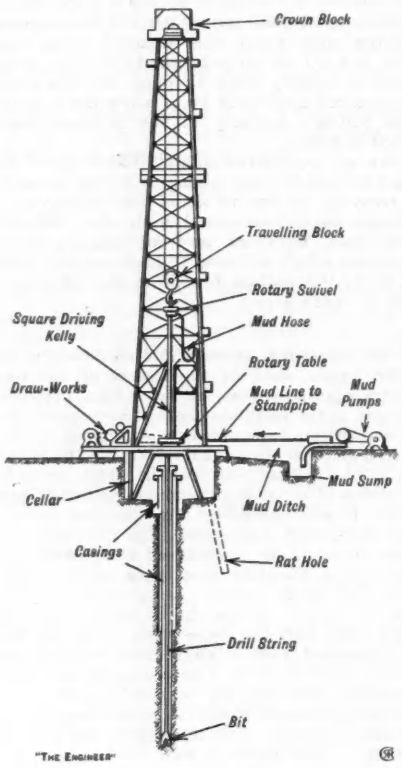


FIG. 4—DERRICK AND RIG

The existence and location of such structures having been discovered by geologists and geophysicists by means of torsion balance and seismograph methods, the drilling crew begins work. Small bore exploratory holes are frequently sunk, using diamond core bits and bringing up cores which when correctly oriented show the angle and direction of stratum dip. When sufficient information has been gathered, work on a production well is commenced, the drilling crew erecting a steel derrick some 140ft. high over a cellar 15 or 20ft. deep. The purpose of this cellar is to remove the loose top soil and to provide a space beneath the derrick floor where the casings will terminate, and where valves will be set in preparation against a blowout. It is also intended for ultimate production purposes in the event of the well producing oil. The earlier wells, which rarely exceeded 2000ft. in depth, were mostly drilled by the percussion method, but in view of the greater depths now necessary, most modern rigs are of the rotary type. With this type of rig depths of 8000ft. or more are common, the present record depth being 15,000ft., or just under 3 miles.

The equipment associated with a rig of this type for deep drilling would consist of the "draw-works," a heavy duty 4-speed winch equipped with sand reel, cat-line bollards, and water-cooled brakes, a rotary table, and slush pumps, the last mentioned being heavy duty reciprocating units of the two-cylinder double acting type. This equipment, together with the tools, bits, &c., has been standardized and has been proved to have ample capacity for present-day needs and sufficient reserve for even greater depths. It is, therefore, only in connection with equipment for the generation and application of power that the greatest variation of design exists, and it is in this direction that manufacturers are looking in an endeavour to reduce production costs.

Of the direct drives, steam was the first choice for obvious reasons, but with the development of the oil engine the priority of steam was challenged, since the oil engine can be operated from the natural casing-head gas and requires but little water. On the other hand, a large steam rig may require 8000 gallons of good water per day for make-up on a battery of five boilers, a consideration of vital importance in undeveloped country where good water may be scarce.

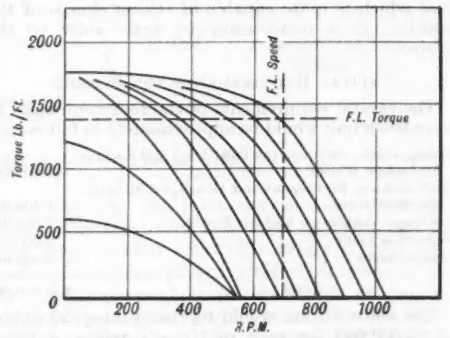
As a direct drive, however, the oil engine has the disadvantage of being unable to maintain an overload, and it cannot be stalled. In such drives it is necessary, therefore, to incorporate a fluid coupling, which is both costly and of low overall efficiency since it relies upon slip. For some years the electric drive has been popular in established fields where power supply is available, and is now being received with favour for use in exploratory drilling as it can be combined conveniently with an oil engine-driven generating set.

Experience has shown that D.C. equipments are most suitable for drilling duties, and it was therefore to be expected that the Ward Leonard type of equipment should be selected for general use. A study of the various duties indicates, however, that although this scheme gives satisfactory results, the characteristics obtained could be improved upon, particularly in respect of the rotary table and slush pump drives. With these considerations in view, The British Thomson-Houston Co., Ltd., has developed an improved scheme which incorporates different characteristics for each drive.

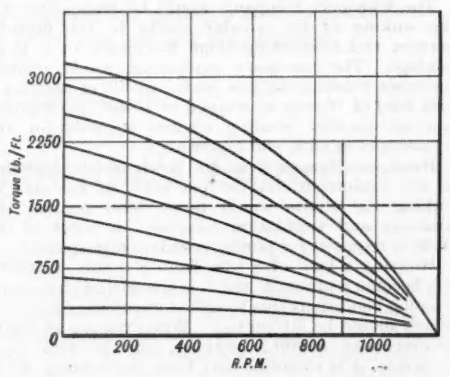
A brief description of the operation of a rotary rig will probably be of assistance in explaining the merits of this scheme. Reference should also be made to Fig. 4. The drill pipe, which may vary from 3½in. to 6⅝in. outside diameter, is usually handled in lengths of 90ft., the drill bit being screwed to the lower end and a square section driving kelly being mounted at the top. This kelly slides through a square hole formed by slips mounted in the rotary table and the drill string is thus rotated. The drill pipe and tools are suspended from a rotary swivel, which is in turn carried by a hook on the travelling block, the lines passing over the crown block and down to the draw-works drum where the weight is held on the brakes, to be released as the depth is increased, thus enabling the weight on the bit to be regulated.

As the depth increases it becomes necessary to add further lengths of drill pipe; the following procedure is then adopted: The whole string is hoisted by the draw-works and suspended from the rotary table by means of taper slips wedging the pipe. The kelly is unscrewed, and set aside in the "rat-hole," a further length of pipe taken from the derrick stand, lowered under gravity and jointed to the pipe projecting from the hole. Joints are of the taper thread screwed type and are run up tight by clamp tongs operated by a rope from the draw-works bollards. The kelly is then replaced, the string is hoisted, and the taper slips removed, the kelly is lowered on the brakes to the bottom, the squared driving slips are inserted in the rotary table, and drilling proceeds. A similar procedure is followed when it becomes necessary to change the bit owing to wear or change of strata; and when it is realized that in difficult drilling the time for changing the bit may exceed the drilling time, the necessity for maximum speed of operation will be evident. The approximate time for the "round trip" (as this operation is called) may be as low as 2 hours for a 5000ft. hole.

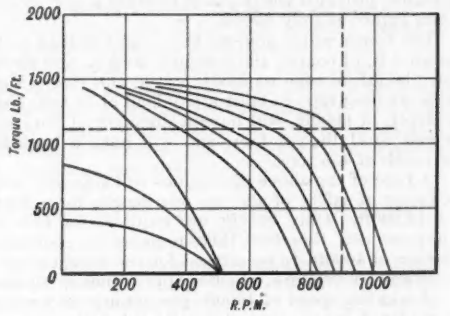
The rotary table, by means of which the drill is rotated, is frequently driven from the same motor as the draw-works, but the modern trend is to have a separate drive for this unit, since only about one-third of the draw-works power is required to rotate. The drill may be required to rotate at any speed up to about 250 r.p.m., dependent upon the nature of the formation being drilled. It is also essential that rotation may be reversed for unscrewing pipe and "fishing" for broken tools left in the hole. As drilling proceeds, the bit will obviously encounter successive changes of stratum, and it will break through from an easily drillable material into sticky clay or other clogging substance, and with a constant weight on the bit. This may cause excessive torque in the drill pipe with consequent fracture and costly "fishing" operations.



TYPICAL TORQUE / SPEED CURVE 250 H.P. SLUSH PUMP MOTOR.



TYPICAL TORQUE / SPEED CURVE 300 H.P. DRAW-WORKS MOTOR.



TYPICAL TORQUE / SPEED CURVE 150 H.P. ROTARY TABLE MOTOR.
"The Engineer"

FIG. 5–7—TYPICAL TORQUE-SPEED CURVES

The remaining chief item of equipment comprises the mud or slush pumps, by means of which liquid mud is circulated down the centre of the drill pipe, to emerge through holes in the bit, and return to the surface between the drill and the casing. The purpose of this mud, which is weighted to increase the specific gravity and regulate the viscosity, is to lubricate the drill, to return the borings to the sur-

* Contributed by the B.T.H. Company.

face, to " mud-off " porous strata, and to hold a back pressure on any gas which may be encountered.

These pumps deliver at pressures up to 2000 lb. per square inch dependent on the size of liners fitted, and on depth and gas back pressure. It is essential that while the drill is in the hole, either stationary or rotating, the mud circulation must not stop, as

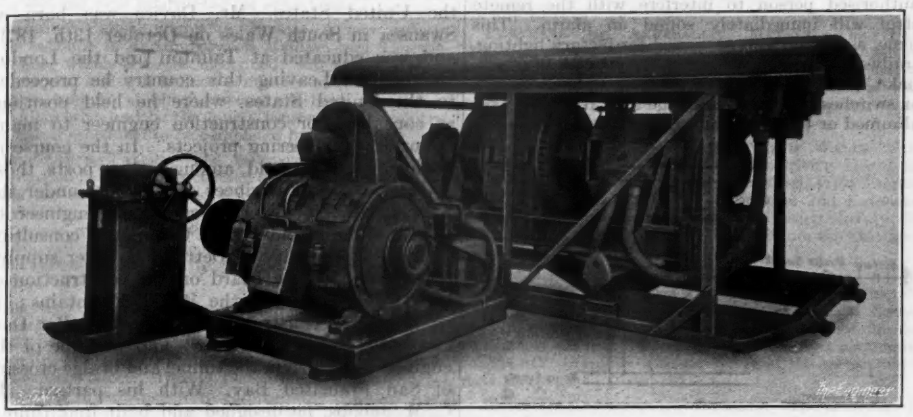


FIG. 8—GENERATING SET, SLUSH PUMP AND CONTROLLER

within five minutes of failure the drill may be " frozen " in.

During drilling, blockages may frequently occur either in the drill or in the hole that would cause an immediate rise in pressure, and this pressure must be maintained until the obstruction is cleared. The drive must, therefore, be capable of maintaining this pressure even under conditions of a stall which may be for periods up to half-an-hour. It will be seen that for the draw-works drive the motor must be capable of good acceleration and high starting torque, the latter being especially necessary when attempting to pull a " frozen " drill string. The rotary table drive must have low inertia, and should have the maximum stalled torque restrained to a value commensurate with the strength of the drill pipe, so that the drive can stall before the drill breaks ; also, a good range of speed must be available. For the slush pump drive, it is essential that the motor can withstand a stalled condition for periods up to half-an-hour, and the maximum stalled torque must be restrained so that the ultimate hydraulic pressure is within a safe value for the pump. This stalled torque should be the same for all speeds since it is general practice to circulate a large volume at shallow depth and to reduce

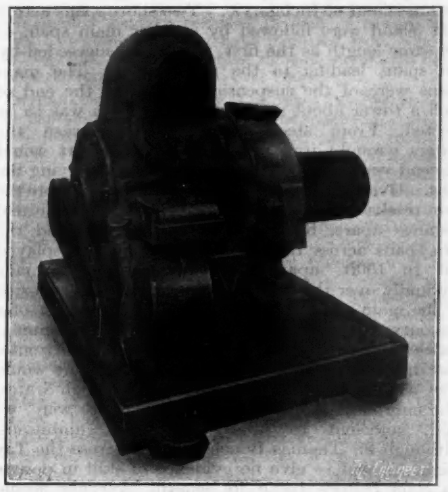


FIG. 9—SLUSH PUMP MOTOR AND BOOSTER

the volume and increase the pressure as the depth increases.

The scheme adopted by the B.T.H. Company incorporates these desirable features, and Figs. 5, 6, and 7 show typical motor torque/speed characteristic curves for these drives. The scheme consists of a controlled constant current system whereby the current remains substantially constant for any given controller setting, and the voltage is allowed to vary between maximum at full load and zero when the motor is stalled. The desired characteristics are obtained by the use of field boosters, complete control being effected by handwheel operation at the derrick floor. The complete equipment consists of one or more constant current generating units for oil engine or A.C. motor drive ; slush pump, draw-works, and rotary table motors of the forced ventilated type, each equipped with belt-driven field booster and integrally mounted motor driven fan ; an exciter set, belt driven from the generator ; a main selection switch panel with resistances and separate handwheel operated oil immersed controllers for each motor. Fig. 8 shows an induction motor-driven generating set, a slush pump, motor and controller : similar sets have also been supplied for oil engine drive. Fig. 9 shows the slush pump motor with its associated field booster mounted on a baseplate. Field tests on an equipment of this type have demonstrated its capability of withstanding a complete stall for long periods without damage or dangerous overheating, and under actual tests the motor speed was only 0·3 r.p.m. It has also been found that with this type of motor it is possible to compound two mud pumps for the high pressures required when cementing or testing, without the use of an equaliser chamber, a condition hitherto stated to be impracticable with other than direct acting steam pumps.

As previously explained, the viscosity of crude petroleum varies widely in different localities and such deposits may or may not be attended by large gas pressure. In the former case production of the well may be greatly simplified, although considerable difficulty may be experienced in controlling this pressure, which if not anticipated may result in the well blowing wild. It is often necessary to put a well on the pump, in which case a beam or pitman suction pump is used, consisting of a beam-operated sucker rod, reciprocating in the well and arranged with a series of valves so that lifting is done in stages, the stroke being about 20in.

In the case of a field having a number of wells " on the pump " the wells are usually arranged with one central drive, and the individual pumps are operated therefrom by pull rods, which sometimes extend for long distances and pass over and around pulleys. The drive for this service usually consists of a slip-ring motor capable of 10 to 15 per cent. speed reduction. The motor must be of the flameproof type or must have flameproof slip-ring gear, unless the installation is of the central drive type described above, and is remote from any gas zone. Pipe-line pumping and tanking duties present no special problems except again the necessity for flameproof equipment.

Similar conditions apply in refineries and cracking plants as in oil fields, and such factors as the development of markets, national demands, etc., have necessitated vastly increased output and specific requirements of physical and chemical properties. In the early days of internal combustion engines, the design was based on a " straight run " fuel having a certain volatility and specific gravity. Such fuel required relatively simple plant for its production, whereas the demands of the modern higher efficiency engines with increased compression ratio and speed, now call for fuels to rigid specification and high octane number, which can only be produced by a complex process entailing separation of the butanes and propanes, removal of H_2S and SO_2, de-hydrating, stabilising, and polymerization before the final petrol blend is produced.

In the early days it was also customary to allow the natural gas of the well to escape, whereas this is now stabilised and utilised, as much as ten million cubic feet of gas having been estimated to issue from a gas well daily. It will therefore be seen that although originally a few simple pumps sufficed, it has now become necessary to arrange for drives to numerous pumps, compressors, vacuum pumps, motor operated valves, etc., most of which are operating in an atmosphere containing petroleum vapour in explosive quantities. A large refinery may have upwards of 50 pumps, serving through 40 miles of piping, such plant being capable of dealing with a million gallons of " crude " daily.

In such a hazardous situation, the importance of flameproof electrical apparatus is obvious ; and for such conditions it has been specified that : " In any situation in which inflammable gas is normally present, or is likely to occur in quantities sufficient to be indicative of danger, all apparatus should be constructed, worked, and installed so that there is no risk of open sparking."

The impossibility of excluding inflammable gas from entering electrical equipment has long been realised, and the design of flameproof enclosure therefore aims at preventing an internal explosion from igniting any explosive mixture external to the apparatus. It has been found that joints and passages can be used in the construction, provided these are kept within certain limits so that the flame (resulting from the most severe internal explosion) passing between the walls of such a passage is so cooled by contact that it cannot ignite an explosive mixture external to the enclosure.

A range of motors and control gear suitable for such duties and situations has been developed by the B.T.H. Company, this equipment having been awarded the Ministry of Mines Buxton Certificate of flameproofness for operation in group II gases (viz. petroleum and its constituent vapours, butane, propane, etc.). A group of typical flameproof squirrel-cage motors which were supplied for the Edeleanu plant of a large refinery is shown in Fig. 10.

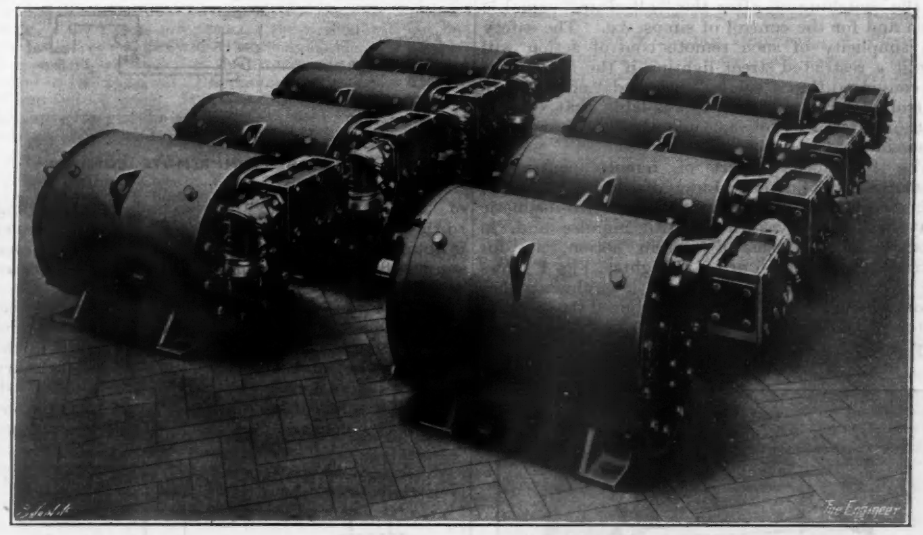


FIG. 10—TOTALLY ENCLOSED FLAMEPROOF MOTOR

Measuring Distance by Radio.—A new device for utilising radio waves to measure distances between invisible or visible points in any weather or locality has been invented by two Soviet scientists, L. I. Mandelstam and N. D. Papalexi. The device is called a radio-telemeter consisting of two special receiving and transmitting sets which are located at the points the distance between which has to be measured. Radio waves of a determined length (this must be known exactly) are emitted from one set and received by the other, from which they are relayed back to their source, and compared upon reception with the original radiation. It is then possible with the aid of some simple measurements, based on the exact knowledge of the speed with which radio waves travel, to calculate with precision the number of radio waves and the distance between the two sets, and in this way to establish the distance between the two points. The development of the telemeter, carried on during the last few years, has been accompanied by intensive investigation into the influence of the earth on the speed of radio wave diffusion, and of the altitude at which the surface of the earth ceases to influence the radio waves. In this connection, the Physics Institute of the Academy of Sciences of the U.S.S.R. sent out several expeditions to the Arctic, the Black Sea, and to the desert regions of the Union. Five navigators of the Civil Aviation Fleet of the U.S.S.R., in collaboration with the scientists of the Institute, also carried out several flights at altitudes varying from 4921ft. to 9842ft. in balloons, and two substratosphere flights, which yielded sufficient material for a complete study of the problem. This material will facilitate a more effective use of the radio-telemeter, which so far has been applied experimentally by the Hydrographic Department of the Northern Sea Route Administration.

M

Electrical Remote Control

IN the interests of public safety, cost, and reduction in the number of men and the necessity for synchronised action, there are many instances in which the control of certain protective actions should not be left in the hands of several persons. In factories engaged on war work, railway stations, &c., where despite the normal black-out a certain number of lights have to remain on, it is then desirable that all lights should be extinguished instantaneously when an air raid warning is given. By means of remote control such action can be performed efficiently from a central point. Only one official has to operate a single switch in order to extinguish all external lights.

Such a centralised control will not only be used

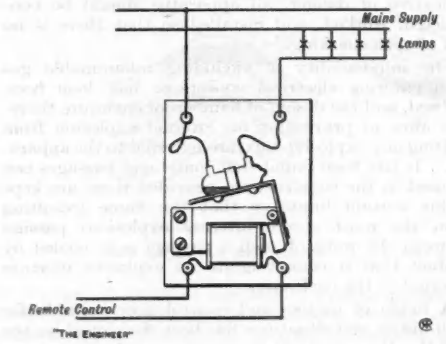


FIG. 1—ELECTRO-MAGNETIC RELAY FOR REMOTE CONTROL

for the switching off of lights. It will also be used for the switching on after the "all clear" signal is given and for the control of sirens, &c. The safety and simplicity of such remote control action will permit a restricted street lighting if the authorities are convinced that a single "on" and "off" remote control of street lighting is available that ensures that interference by an unauthorised person is impossible.

The fundamental part of remote control as developed by Londex, Ltd., of Anerley Works, 207, Anerley Road, S.E.20, is an electro-magnetic relay which receives the control impulse and, in consequence, performs a certain action, as, for instance, switching on or off all lights. Fig. 1 shows the principle of such a relay, and it is obvious that as long as the coil of the relay is energised the mercury switch will close an electric circuit. The coil requires only a very small current, but the mercury switch

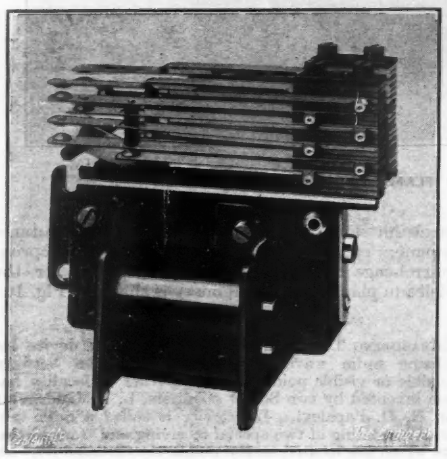


FIG. 2—RELAY WITH SILVER CONTACTS

can deal with lighting loads of 50 amperes and more. It is not always necessary to use mercury contacts, and in the case of smaller loads, silver or tungsten contacts are used, as shown in Fig. 2. This type of relay is especially suitable for use on ships, aircraft, and railways, as it can be mounted in any position, whereas mercury tubes have to be mounted in a place free from vibration and in a horizontal position.

The remote control of groups of street lamps is shown in Fig. 3. There is only one pilot wire necessary, and as soon as the manually operated master switch is closed, the mercury switches on the two "Londex" relays are closed and the two street lighting groups remain on until the master switch is opened.

The single wire which is used may be a thin telephone wire, and it will be seen that in the case of any damage to the pilot wire or to the supply of the control current, the relays will immediately open the lighting circuits so that every guarantee is given that unwanted and unintentional "remaining on" of lights is impossible. The pilot wire can be connected up in such a way that an attempt by an unauthorised person to interfere with the remote control will immediately sound an alarm. This scheme, as in Fig. 3, is also used for factory lighting, in railway stations, &c., and if, instead of single "make" and "break" mercury switches, change-over switches are used, a change-over from ordinary to dimmed or blue lighting can be effected. Remote

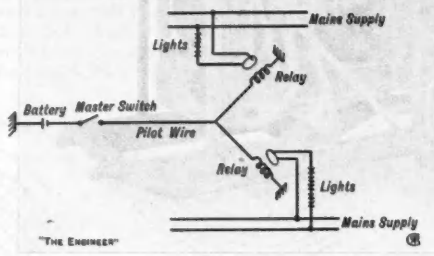


FIG. 3—REMOTE CONTROL OF A GROUP OF LAMPS

control along these lines can replace the complete "black-out."

Besides the control of lights, these relays can be used for the control of sirens, and Fig. 4 shows an arrangement where a siren is controlled by means of several push-buttons to give either the warning or the "all clear" signal. If one of the "all clear" push-buttons is pressed once, the "Londex" relay closes the siren circuit for two minutes, and if the "warning" push-button is pressed, the relay controls the siren for two minutes in a certain cycle consisting

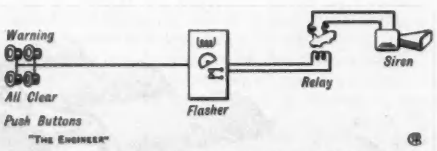


FIG. 4—PUSH BUTTON REMOTE CONTROL

of five seconds on and three seconds off, according to the Home Office regulations. The warbling sound is obtained by means of the "Londex" five to three seconds flasher, which controls the "Londex" relay as indicated in Fig. 4.

Another wide field for such relays is the automatic remote control of emergency lighting, and fire and burglar alarms. In this case the relay works in the opposite way, and Fig. 5 shows that the mercury switch remains open as long as the coil is energised. The main application of this type of relay is the control of emergency lighting in hospitals, cinemas,

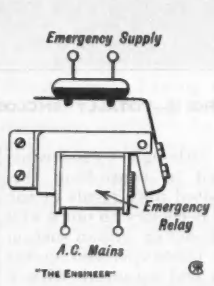


FIG. 5—RELAY FOR SWITCHING ON EMERGENCY LIGHTING

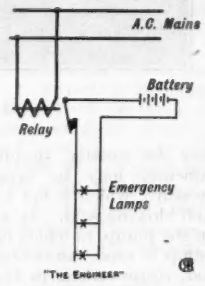


FIG. 6—WIRING DIAGRAM OF EMERGENCY RELAY

air raid shelters, &c. From Fig. 6 it will be seen that as soon as the mains supply fails, the relay switches on the emergency battery lamps. As soon as the mains are restored, the emergency battery lighting is switched off automatically.

These relays are of importance for the lighting control in the operating theatre of hospitals when the emergency lights are automatically switched on when a failure in the mains supply occurs. A combination of such relays is used to give an alarm signal to the engineer in charge informing him that the emergency lighting system has come into operation. The same type of "Londex" relay is used for automatic fire and burglar alarm, and if suitably arranged under the roof of a building an alarm signal will be given to the air raid shelter if an incendiary bomb has fallen on the house.

SAFETY IN MINES RESEARCH BOARD.—Following the retirement of Sir Edward Troup from the Safety in Mines Research Board the Secretary of Mines announces Sir Malcolm Delevingne has been appointed chairman. Sir Edward served as chairman for sixteen years and has retired for reasons of health.

Obituary

J. V. DAVIES

A WIDE circle of engineers will hear with deep regret of the death of Mr. John Vipond Davies which occurred on Wednesday, October 4th, in the United States. Mr. Davies was born at Swansea in South Wales on October 13th, 1879, and was educated at Taunton and the London University. Leaving this country he proceeded to the United States, where he held positions as consulting or construction engineer to many important engineering projects. In the course of his long career he held, amongst other posts, those of chief assistant engineer of a tunnel under the East River, New York; consulting engineer to the Brooklyn Rapid Transit Company; consulting engineer to the City of Detroit for water supply; membership of the board on the construction of the Moffat Tunnel in the Rocky Mountains; in charge of the construction of the Hales Bar Dam across the Tennessee River; and was one of the engineers engaged in the tunnel and bridge crossing of San Francisco Bay. With his partner, Mr. C. M. Jacobs, he designed and built four tunnels under the Hudson River and planned the Pennsylvania Railroad tunnels under the Hudson and East Rivers. Mr. Davies was also closely associated with other important projects in France, Mexico, and other countries. He received many awards from the leading institutions, including the Telford Gold Medal, the Norman Gold Medal, the Thomas Fitch Rowland prize, and the Fowler professional award. He was a member of the American Society of Civil Engineers; the Institution of Civil Engineers; American Institute of Mining Engineers; the United Engineering Society; and the American Institution of Consulting Engineers.

Sixty Years Ago

BOUCH'S FORTH BRIDGE

IN our issue of October 17th, 1879, we published drawings of Sir Thomas Bouch's proposed Forth Bridge. The design showed a total of twenty-nine spans with an aggregate length of over 6900ft. Fifteen approach spans on the south side led to a main span of 1603ft. 6in. which landed on the mid-stream island of Inchgarvie. Two short spans across that island were followed by another main span, of the same length as the first, which was succeeded by ten spans leading to the north shore. The main spans were of the suspension type. At the end of each a tower about six hundred feet high was to be erected. From steel chains slung between the towers wrought iron rods spaced 50ft. apart would descend vertically to support the girders carrying the rails. Over the approach spans nearest each shore the two tracks of rails would be spaced at a normal distance apart, but over the main spans and the two spans across Inchgarvie they would be splayed out to 100ft. apart, the widening being made gradually over the three approach spans on each side of the main spans. The towers were to consist of a masonry foundation carrying cast iron columns—sixteen to each tower—bound together by horizontal and diagonal bracing. The suspended girders would give a clear headroom of 150ft. above high water. The enormous dimensions of the structure were, we said, sufficient to satisfy the most ambitious. Although Sir Thomas Bouch's bridge across the Tay might be said to give no evidence of skill in design, its chief feature being its length, everyone would admit that in the Forth Bridge he had exceeded all his predecessors in boldness. The difficulties likely to be encountered in erecting the bridge would be sufficient almost to repel the boldest of contractors and it was not surprising that some well-known bridge builders had refused the responsibility of tendering for its erection. Hesitation on the financial side was also being encountered. To encourage capitalists to subscribe towards the cost of building the bridge a plan had been devised for letting the contracts for its construction before the money required had been raised, the object being, we presumed, to give capitalists faith in the possibility of realising the design. We expressed surprise at the omission to submit the design to the consideration of a few highly-qualified engineers and urged that a discussion of its merits and demerits could not fail to be of value. . . . Before three months had passed the Tay Bridge collapsed and the fate of Bouch's proposed structure across the Forth was tragically sealed.

THE COAL INDUSTRY.—During the four weeks ended August 19th last, the coal output of Great Britain totalled 15,577,100 tons. The number of wage earners during the four weeks averaged 766,968.

Rail and Road

ACCIDENT ON THE L.M.S.—On the evening of September 27th, a London Midland and Scottish Railway electric train approaching Willesden Junction on the Addison Road—Broad Street line was derailed. It partly overturned and a few passengers were slightly hurt. Rush hour services were interrupted for some time.

RAILWAY CONSTRUCTION IN JAPAN.—A new railway is to be built in Japan between Maibara and Tsuruga. The line, which is to be electrified, will cost about 15 million yen, and will include a number of tunnels. One of these tunnels, at Shinfukasaka, will have a length of 5·27 kilometres and be the fourth largest in the country. The line is scheduled to be completed by June, 1941.

AMBULANCE TRAINS.—The railways of this country are engaged in the construction of a number of ambulance trains for use at home and abroad. Several trains are reported to have been completed, and we understand that work upon different sections has been entrusted to seven railway workshops in various parts of the country. Special workings will be arranged for these trains whenever required.

ROADS IN THE ARGENTINE REPUBLIC.—In a report on the Argentine Republic, Mr. W. N. Storey says that at the present rate of progress the ten-year road plan, begun in 1933, will exceed the estimated cost of 315 million pesos paper. During 1938 a number of highways of national importance were completed. The new road between Buenos Aires and Mardel Plata (over 400 kilometres in length) was opened to traffic, and the final section of the new Cordoba—Santa Fe road (300 kilometres) was completed.

SOLID TYRES.—The Ministry of Transport announces that it is proposed to postpone the requirements of regulations that heavy motor cars and motor cars on solid tyres must, with certain minor exceptions, be converted to pneumatic tyres by January 1st, 1940. This will mean that vehicles in those classes which were registered before 1933 may continue to run on solid tyres, but that new vehicles will still have to be fitted with pneumatics. The concession would also extend to trailers which would have been affected by the conversion requirements.

A MODERN PASSENGER COACH YARD.—The Southern Pacific Railroad in the United States recently completed a big new passenger coach yard. The yard has twelve servicing tracks ranging in length from 1350ft. to 2200ft., capable of accommodating 177 coaches, and three storage tracks for 91 coaches. Most of the servicing tracks are spaced 22ft. apart, and between them run low asphalt platforms bordered by drainage gutters. Along the centre of alternate platforms overhead lines, carrying air, water, steam, and power are mounted on old rails set upright at intervals in the platforms.

TRENDS IN ROAD CONSTRUCTION IN AMERICA.—A report has been issued by a Joint Committee on Roadside Development of the Highway Research Board and the American Association of State Highway Officials. It is stated that during the past eight years in the United States there has been a steady trend away from the three lane highway in favour of divided highways with four or more traffic lanes. The existing ten foot wide traffic lane is now steadily being superseded by one of eleven feet. Widths of graded roadbed have increased from 50ft. in 1932 to 112ft. in 1939–40, whilst right-of-way widths have increased from about 80ft. to over 200ft.

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION.—The September bulletin of the International Railway Congress Association gives the following list of members elected to the Permanent Commission in place of members who resigned: Mr. O. V. Bulleid, Chief Mechanical Engineer, Southern Railway; Mr. K. Sikama, Manager of the Berlin office of the Japanese Government Railways; Mr. J. A. Bell, India Office; M. Leclerc du Sablon, Directeur du Service des Approvisionnements, Commandes et Marchés, French National Railways Company; H. E. Tarraf Aly Bey, Under Secretary of State, Ministry of Communications, Egypt; M. A. Porchez, Directeur du Service Central des Installations fixes, French National Railways Company; Sr. Arturo Noni, General Manager, Railway Department, Ministry of Public Works of the Argentine Republic; Prof. Dr. J. Goudriaan, President, Netherlands Railway Company; Mr. W. A. Stanier, Chief Mechanical Engineer, L.M.S.R.; Mr. C. H. Newton, Chief General Manager, L.N.E.R.; Herr. W. Kleinmann, Staatssekretär, Reichsbahn; Dr. Ing. eh. Max Leibbrand, Ministerial-direktor, Reichsbahn; Herr Werner Bergmann, Ministerial-direktor, Reichsbahn; M. Jean Berthelot, Assistant General Manager, French National Railways Company. Sir Nigel Gresley, Chief Mechanical Engineer, L.N.E.R., Member of the Permanent Commission, has become a Member of the Executive Committee.

WROUGHT STEEL WHEELS.—A recently issued bulletin of the Engineering Experiment Station of the University of Illinois, is entitled, "An Investigation of Wrought Steel Railway Car Wheels: Tests of Strength Properties of Wrought Steel Car Wheels." The investigations are being carried out by Messrs. T. J. Dolan and R. L. Brown, and the main purpose of the tests reported in this bulletin were to locate the most highly-stressed portions of the wheel under several types of loading, and to calculate, from strain measurements, the magnitude of the larger stresses occurring in the wheel under a given set of loading conditions. The investigation was confined to a study of the strength properties of wrought steel wheels of the standard A.A.R. design. Observations were made of the strains developed in wheels while being pressed on standard axles, and of the strains and deflections of wheel and axle when subjected to vertical loads and to horizontal flange loadings. The tests were made on medium carbon-steel wheels, and also on silico-manganese alloy-steel wheels, since it was felt that, if strength is the main item to consider, the silico-manganese alloy-steel wheel might replace the carbon-steel wheel because of the greater strength of the alloy steel. We are informed that until March 1st, 1940, or until the supply available for free distribution is exhausted, copies of the bulletin may be obtained without charge upon application to Engineering Experiment Station, Urbana, Illinois, U.S.A.

Miscellanea

GAS RESEARCH BOARD.—The Council of the Gas Research Board has decided to postpone the appointment of a Director of Research and to appoint Dr. W. T. K. Braunholtz as Acting Director of Research. Dr. Braunholtz will continue to be the Secretary of the Institution of Gas Engineers.

PURCHASE OF AUSTRALIAN METALS.—The Prime Minister of Australia has announced that arrangements have been completed for Great Britain to purchase the whole of the surplus stocks of Australian refined zinc and copper and most lead stocks, at prices approximately those ruling before the outbreak of hostilities.

NORTH-WEST ENGLAND AND NORTH WALES ELECTRICITY SCHEMES.—The Central Electricity Board has adopted, without modification, the North-West England and North Wales Electricity (Alteration and Extension) Scheme, 1939, details of which were published on July 21st. Copies of the scheme may be obtained from the Stationery Office.

WIRELESS LICENCES.—The Post Office issued 387,882 wireless receiving licences during August, a net increase of 24,768, after making allowance for expired licences and renewals. The approximate number of licences in force at the end of August was 9,044,100, an increase of 354,912 compared with the figure at the corresponding date last year.

MINES DEPARTMENT APPOINTMENT.—The Secretary for Mines, by arrangement with the Coal Commission, has appointed Mr. C. S. Hurst to a post in the Mines Department for the period of the war. Mr. Hurst retains his post as Secretary of the Coal Commission and will continue to deal with such affairs of the Commission as require his personal attention.

CRUCIBLE LININGS.—An extract in the *Iron and Coal Trades Review* states that temperatures up to 1460 deg. can be withstood by crucible linings composed of a mixture of 67·5 per cent. of finely ground quartz, 12·5 per cent. of maglite, 10 per cent. refractory clay, and 10 per cent. of ground glass. Crucibles with these linings are said to be able to stand 330 to 350 melts.

THE NEWCOMEN SOCIETY.—Owing to the outbreak of war and the dislocation consequent thereon, the Council, on September 20th, at a specially convened meeting decided to discontinue the monthly meetings for the time being. The papers arranged for the session will not be stopped, however, but will be made available, it is hoped, to members who ask for them on or about the dates stated in the syllabus. Discussion on the papers should be sent in in writing. It is hoped to mark October 28th, the anniversary of the death of John Smeaton, in a special manner, and if this is practicable, details will be issued.

WORKS A.R.P.—We have received from British Timken Limited, Chester Road, Aston, Birmingham, a copy of an A.R.P. booklet which has been issued to all the company's employees. The inside cover of the booklet comprises a form on which is entered the employee's particulars, including his shelter number and method of procedure in time of emergency, together with details of his respirator. The contents of the booklet are particularly devoted to air raid gas attack, giving details of the various gases and the first aid treatment of casualties. Much useful information is also given on the care, cleaning, and use of respirators.

PROPOSED NEW GENERATING STATION AT CROYDON.—The chairman of the Electricity Commission recently heard the objections of the Croydon ratepayers to the erection of a new power station. The proposed plant would consist of two 30,000 kW turbo-alternator sets with boiler plant and cooling towers, the cost being about £1,300,000. The existing plant has a maximum output of 88,000 kW and the maximum demand is about 50,000 kW and, although there is room for another set, it is considered unwise to install it as a new station will be required in any event in about four years. The principal objection is that the proposed station would create a nuisance in the way of precipitated vapour from the cooling towers and dust from the chimneys.

GRAVITY DIE CASTINGS IN ALUMINIUM.—Some interesting facts and figures on the process of producing aluminium alloy castings by means of gravity dies and on the design of the castings themselves are given in a recent bulletin issued by the Northern Aluminium Company. The use of gravity dies, or chill moulds, is recommended in the production of aluminium castings for reasons of speed, better finish, and higher mechanical properties in the finished casting. It is stated that in the production of the simpler type of automobile pistons for example, five times as many can be cast per hour as when sand moulding is employed. Greater dimensional accuracy is obtained, commercial tolerances being roughly plus or minus one-thousandth of an inch. Finer grain structure is also obtained by using gravity dies, with a correspondingly favourable effect on the mechanical properties of the castings. The most suitable alloys to use for castings of various types are listed and the design of gravity dies is discussed in the publication.

HIGH-SPEED OIL-ENGINE BEARINGS.—A paper has been presented before the American Society of Mechanical Engineers by Mr. A. T. McDonald on some factors in the lubrication of high-speed oil engines. He pointed out that a little considered cause in the development of high temperatures, that eventually result in bearing failure, is the use of crankcase lubricants for extended periods beyond their limits of useful life. This practice, he said, results in increased viscosity or excessive thickening of the lubricant. A reduction in oil flow with the consequent lessening of heat dissipation through this source results in structural change in the bearing material, which is conducive to bearing failure. Mr. McDonald showed examples of two bearings which had been run under identical conditions in the same engine. One of the bearings had its lubricant changed every 60 hours and after 2500 hours was still suitable for service. The other bearing did not have its oil changed and although every effort was made to keep carbonaceous material from the lubricant the bearing failed after 500 hours service.

Air and Water

THE AUSTRALIAN NAVY.—The Commonwealth Prime Minister has announced that the Australian naval programme is to be extended by building and the purchase of small craft. It is unlikely that larger ships are to be added to the Navy.

SUEZ CANAL COMPANY.—Sir Ronald Graham has been nominated for appointment as non-resident director of the Suez Canal Company in succession to Lord Hankey. Mr. N. E. Young has been nominated as a resident director in place of Sir Ian Malcolm who is retiring.

NEW AIR RECORD.—A Russian aeroplane is claimed to have set up a new international speed record by flying a closed triangular course of 3,149 miles at an average speed of 251·6 miles an hour. The machine used is said to have been of the Stal-7 passenger type, having two 960 H.P. engines.

AIR MAIL SERVICES.—Air Mail services *via* France to North and West Africa, South America, and French Indo-China, which were suspended on the outbreak of war, have now been resumed for first class mail. Except to North Africa, where a daily service is in force, the services will operate once weekly and the times of transmission are not quoted.

CONTRABAND CONTROL.—During the first four weeks of the war the quantity of cargo intercepted and detained by this country totalled some 289,000 tons. The success of the British contraband control is such that it is expected that the amounts of cargoes seized will progressively decline in the future as Germany is now practically shut off from her overseas sources of supply.

WELDED SHIPS.—In the opinion of the President of the National Council of American Shipbuilders, Mr. H. Cerrish, since the introduction of iron ships the most outstanding development in shipbuilding has been welding. Practically all ocean-going tonnage from American shipyards is now welded and welding has reduced the net weight of vessels from 10 to 15 per cent.

EXPLOSION ON S.S. "BARONESA."—The Board of Trade has ordered a formal investigation to be held into the circumstances attending a boiler explosion which occurred in the S.S. "Baronesa," at Brocklebank Dock, Liverpool, on July 1st, 1939. The investigation has been fixed for hearing at Niblett Hall, Inner Temple, E.C.4, on Tuesday, October 10th, 1939, to commence at 10.30 a.m.

FRENCH LINE'S MANAGING DIRECTOR.—M. Pierre de Malglaive, who has been for some years managing director of the French Line Ltd., London representatives of the Compagnie Générale Transatlantique, Paris, is now the director in charge of the Service des Transports Maritimes (Services Economiques Français de Londres). His address is now Westminster House, Dean Stanley Street, S.W.1.

CONTROL OF COASTAL SHIPPING.—The Cardiff Coasting and Short Sea Shipping Control Committee has notified the Cardiff and Bristol Channel Shipowners Association that it has begun to function under powers conferred upon it by the Board of Trade. The duty of the committee is to do its utmost to keep the ports free of congestion, and to assist in the circulation of tonnage to the best advantage.

DOCK LABOUR.—Port authorities in this country, and the Transport and General Workers' Union, are preparing a scheme to ensure the adequate supply of dock labour for the exigencies of war-time shipping. Under the scheme the union will take all the necessary steps to supply labour and facilitate the discharging and loading of vessels in any port. It is thought that the scheme when complete will be adopted by the Government.

MERCHANT SHIPPING WAR LOSSES.—Of the fifty-five vessels aggregating 206,143 gross tons sunk during the first five weeks of the war, thirty-four of 150,113 tons were British; five of 14,889 tons German; four of 9209 tons Norwegian; three of 6727 tons Swedish; three of 6418 tons Finnish; two of 6407 tons French; one of 5965 tons Belgian; one of 3933 tons Greek; one of 1514 tons Dutch; and one of 968 tons Russian.

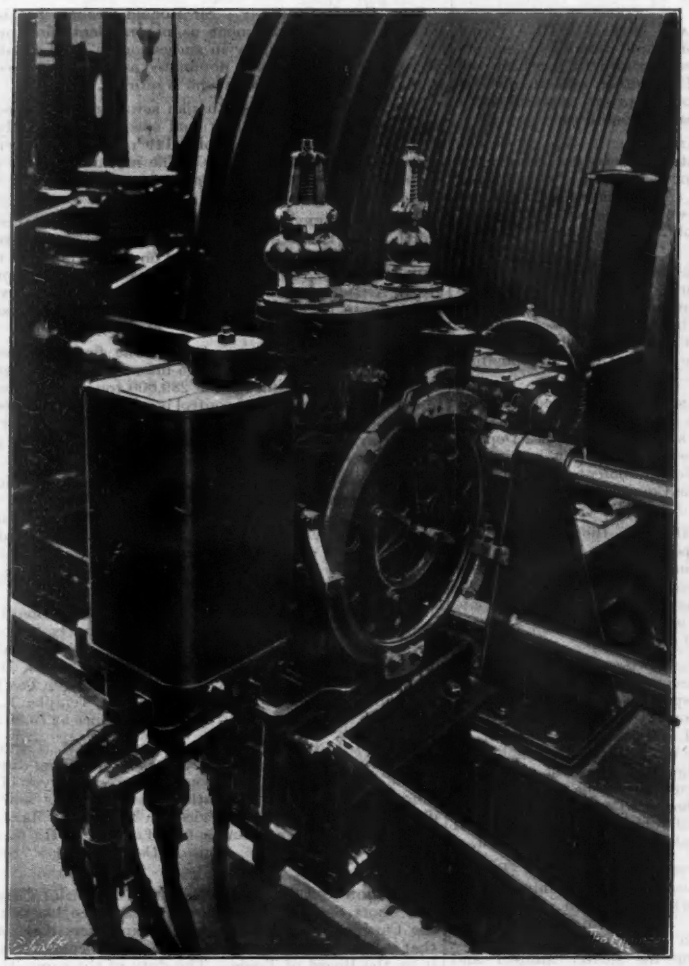
THE UNITED STATES NAVY.—According to the *Journal of Commerce and Shipping Review*, the United States Navy is rapidly being brought up to peak strength to cope with the situation created by the war. It is stated that in all there were 348 ships in commission during the past year. Another 101 were under construction and certain decommissioned destroyers awaited reconditioning. About 2000 aeroplanes are ready for action in the fleet air arm, and it is planned to have 3000 within five years.

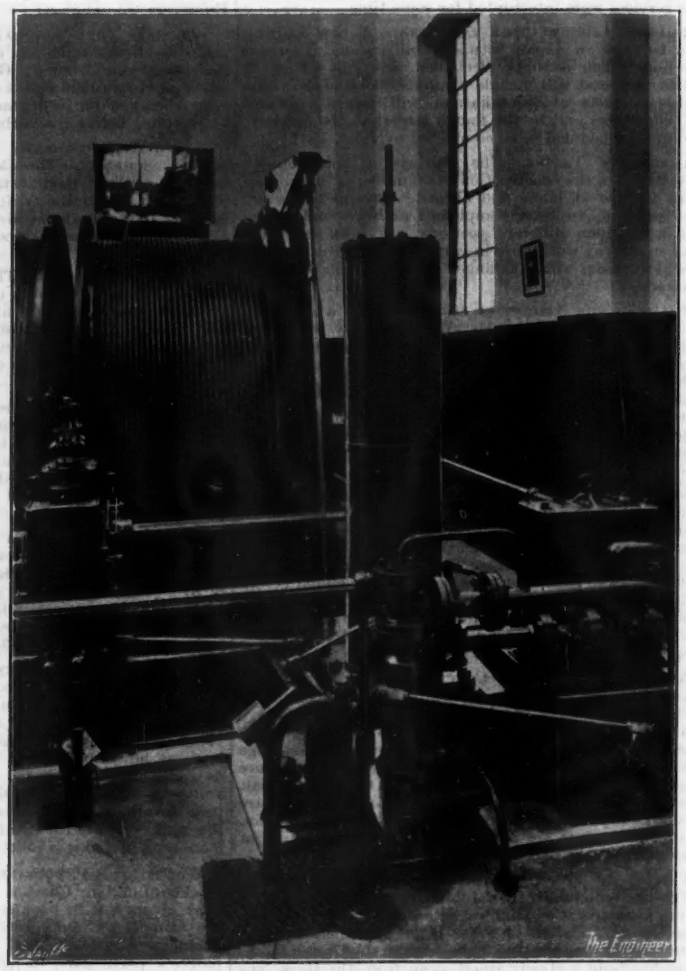
THE SHIPPING BILL.—The President of the Board of Trade has announced that war conditions have necessitated the abandonment of the British Shipping (Assistance) Bill, although construction loans might be made on essential tonnage ordered since March 28th. The Bill provided for a five year tramp subsidy, loans and grants for shipbuilding, assistance for liners, and the creation of a merchant ship reserve. Mr. Stanley said, when making the announcement, that a circular letter will shortly be issued to the shipowners concerned as to the procedure to be followed by those who wish to apply for loans.

LONDON'S SHIPPING.—The recently issued annual report of the Port of London Authority for the year ended March 31st last shows that there was a slight decline in the number of ships entered and cleared as compared with last year. Between 1932 and 1937 the tonnage showed progressive annual increases. The tonnage of imported and exported goods, foreign and coastwise, which passed through the port during the year under review totalled over 41,662,000. The total net register tonnage of ships that arrived and departed with cargoes, and in ballast, from and to British countries and foreign countries and coastwise, was 62,085,840, and of this 34,713,344 tons used the wet dock. Capital expenditure for the year amounted to £522,673, and the year's working resulted in a total revenue of over £5,979,000 and total expenditure of £4,219,980, leaving a balance of revenue of over £1,759,000.

A.C. ELECTRIC WINDER ON THE NORTH-EAST COAST

(For description see page 383)





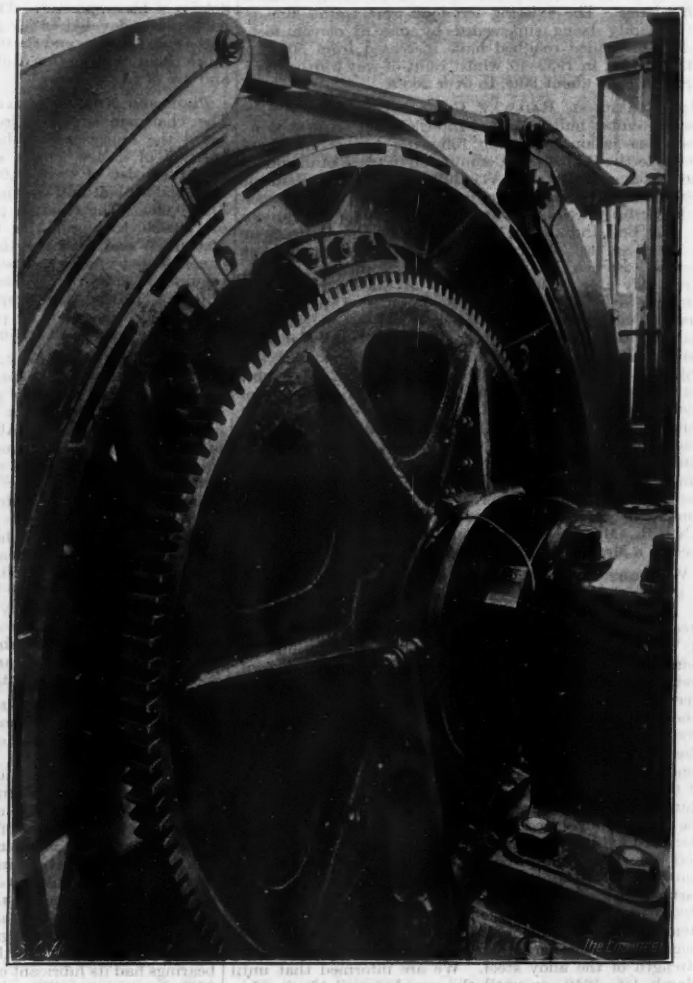


FIG. 1—LILLY CONTROLLER

FIG. 2—BRAKE ENGINE

FIG. 3—DRIVER'S PLATFORM

FIG. 4—CLUTCH ASSEMBLY

The Engineer

OCTOBER 13, 1939

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NOTICE TO READERS

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CHANGES OF ADDRESS

**** Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address : "The Engineer," 28, Essex Street, Strand, London, W.C.2.

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LABOUR IN WAR TIME

THE official returns show that at the present time some 13,000,000 registered workers are employed in British industries. That does not represent the whole number of workers; but the bulk of those registered belong to one or other of the numerous trades unions. It is on these people that the country relies ultimately for the output of war munitions, products for export, and the thousand and one commodities that are essential to the inhabitants. It is in their power to dislocate all the industries of the country and to prevent the prosecution of the war by arresting the supply of munitions. In other countries of Europe labour can, at the turn of a hand, be made subject to military law. In this country liberty is left to the workpeople, and reliance is placed upon their devotion to their country and to the cause for which it is fighting. That reliance is well placed. The unions have shown their anxiety to further all steps that are being taken to augment the output of war material. On the political side the spokesmen of the Labour party, led by Mr. Greenwood, have, whilst exercising the critical duty of the Opposition, stood side by side with the Government in its determination to bring the war to a successful conclusion. The indications of labour troubles which were visible up to the outbreak of war have almost disappeared. Labour with complete unanimity has sided with the rest of the community in its efforts to defeat once and for all the doctrine of armed force. It has dropped its aggressive programmes and become one in effort with its employers.

Whilst it is impossible not to reflect with some uneasiness upon the changes in social life which must inevitably follow from the influence which is being given to organised labour under the conditions imposed by war, it must be recognised that the only alternative was the militarisation of labour. That is entirely repugnant to the British people. It is conceivable that British labour might be coerced for a time as German labour is coerced, but the end would be disastrous. We need not give a name to what would happen, but we may recall that for several centuries Great Britain has avoided national convulsions by evolution whilst some others have been torn by revolution. That method is characteristic of British policy and of the British people. It is being exhibited now by all the steps taken to maintain harmony and to secure the co-operation of all classes of the community. A week ago representatives of the General Council of the Trades Union Congress and of the British Employers' Confederation met at the Ministry of Labour for friendly discussion. The Minister suggested the formation of a national advisory committee of labour and employers, but the General Council desired to go further and to see set up for every vital industry an organisation composed of trades unionists and employers which would accept the responsibility for fulfilling the Government's requirements. Briefly, whilst Mr. Brown suggested a single advisory body, the General Council proposed a multiplicity of executive committees. It is understood that the matter has been referred to a committee for consideration. On the day following this meeting, the Prime Minister himself met a deputation from the General Council of the Trades Union Congress for an informal conversation. The assistance which labour could give to the Ministry of Supply was the main subject of discussion. In its own words, this deputation led by Mr. W. Holmes and Sir Walter Citrine, "while affirming the desire of the trade union movement to play its part in the national effort for the prosecution of the war, made representations with regard to the importance of ensuring that there should be both consultation and collaboration between the Government departments concerned and the movement. The Prime Minister, in reply, emphasised the desire of the Government that there should be the most complete understanding and co-operation possible between them and the movement, and he undertook that every endeavour should be made to meet the points raised by the deputation."

There will, we suspect, be a good deal of heart burning over these two meetings. Hitherto, the practice of the Government has been to place its orders with employers and to leave to their federations the settlement of labour questions. Now there would appear to be some danger that the Government may make arrangements direct with the unions, and that the position of the employers' federations may be undermined. With a lively recollection of the result of Mr. Lloyd George's intervention during the last war, it is hardly possible for employers to regard its repetition without anxiety. It is earnestly to be hoped that whilst the Government uses its influence to encourage labour, it will refrain from taking any steps that endanger a system and organisations that have been built up with much care and travail, and which on the whole are working satisfactorily. *A priori* the proposal of the General Council for the setting up of committees composed of representatives of employers and unionists in every vital industry appears to be in harmony with existing conditions, and to be more desirable than direct contact between the trades unions and the Government with the employers only in the background, but no doubt every aspect of the matter will be considered by the *ad hoc* committee mentioned above.

Petrol and Suction Gas in France

RESEARCHES and experiments in France during the past fifteen years to provide home-produced substitutes for imported petrol and fuel oils were undertaken primarily with a military object, which was of more vital importance at the moment than the purely economical results affecting the country's financial situation in normal times. During a war the only thing that counts, in this connection, is an assured complementary supply of fuel independently of imported petrol which is reserved for military and national purposes. As soon as hostilities began it was announced that private motor car owners would be supplied with one grade of petrol, while lorries and other heavy commercial vehicles would continue to run on the petrol-alcohol or petrol-benzol mixture. Then came the rationing of all liquid fuels. The system employed is to bring users into a number of categories beginning with the fighting services, followed by all other classes of petrol consumers according to their importance in national work, and ending with private owners of motor cars. Each month the total quantity of petrol required by each category of consumers will be estimated according to individual declarations of minimum needs which are centralised by the prefects and mayors, and consumers will be supplied with tickets entitling them to purchase petrol up to the limit allotted to them. Naturally, there is no restriction of supplies to the fighting services, and all consumers working in the national interest will have their full allocations of petrol so long as it is possible to supply them. The private consumer must, therefore, content himself with what is left, if there be any. It is at this point that the necessity of complementary supplies of home-produced fuels becomes clear. The Minister of Public Works has more than once appealed to private motor car and lorry owners to restrict the use of their vehicles to an absolute minimum. The chances are that the increasing consumption of petrol for national needs, and the possibility of supplies of imported petroleum being reduced or rendered more precarious by war risks, will deprive the less favoured categories of consumers of means of using lorries and cars, unless they can fall back on a substitute for petrol.

The Minister of Public Works has reiterated instructions to departmental prefects to encourage the use of suction gas, particularly in those departments where ample supplies of wood are available. Charcoal suction gas is the only substitute fuel recommended for long distance transport. Compressed coal gas and electricity are suitable for services within range of supply centres, and are therefore limited mainly to town areas. Practical experience with charcoal suction gas producers had the effect of restricting their use largely to forest regions, and further progress has been almost entirely confined to portable producers employing small oval briquettes made of ground charcoal with an oleaginous binding. This departure from the original idea of utilising wood for suction gas led to the introduction of briquettes composed of coal dust and other ingredients, but as the satisfactory use of portable suction gas producers depends upon an ample distribution of a uniform type of cheap fuel, the State elaborated a plan for the manufacture of charcoal briquettes in a number of centres all over the country, where the fuel would be supplied to consumers without excessive transport charges. Nothing came of this scheme, though makers of producers found in this standardisation of briquettes an encouragement to develop the smaller and lighter types of generators that would be available even for touring cars. A great impulse was given to the movement by the Government's decision to impose the use of home-produced fuels on 10 per cent. of the vehicles owned by omnibus companies, public works' contractors, and all other firms engaged in work more or less subsidised by the State. In view of this compulsory use of home-produced fuels from the end of this year, there has been an active equipment of omnibuses and lorries with suction gas producers, but so far as omnibuses are concerned the companies have not been able to obtain satisfactory results with this fuel. Nevertheless, the compulsion order to run a percentage of vehicles on home-produced fuels has increased considerably the number of lorries fitted with suction gas producers. The military authorities continued to take a close interest in suction gas until it became evident that the use of this fuel could only be entertained for traction outside military services. Suction gas, compressed coal gas, and electricity must be employed for private traction as much as possible.

It is difficult to estimate the number of vehicles now running on suction gas, but an assumed total of something like 7000 must include a large proportion of lorries of a nondescript character of more or less doubtful utility. Private consumers of petrol will now have to give more attention to suction gas if they are to be sure of being able to use freely their lorries and cars. The Government promises to afford them further fiscal relief, and states that suction gas lorries will in no case be requisitioned.

The suction gas problem is complicated by the fact that the fuel cannot compete with petrol under normal conditions, alike as regards efficiency and all round economy, unless the economy is assured by fiscal alleviations that are equivalent to State subsidies. Suction gas can only be competitive when engines are built to run on this fuel, and producers are capable of supplying a gas of constant quality at varying engine speeds. With a wide experience acquired during a long transition stage in adapting petrol engines to run on suction gas, engineers now know how this result may be attained. But there are many difficulties of technique and fuel supply organisation to be overcome, and this, too, without complications and increased costs that eliminate any advantage in economy. There are, in France, 325,000,000 acres of forest and woodlands capable, it is said, of providing 75,000 lorries with an inexhaustible supply of fuel. Nevertheless, the supply is restricted by the necessity of selecting suitable wood for charcoal leaving a minimum of ash and dust. Consumers within range of centres of production can be assured of a guaranteed quality, and this assurance of quality can be given with briquettes distributed everywhere, while providing a form of fuel that allows of the construction of more compact producers. At present, the number of suction gas vehicles on the road, though small, is evidence of the existence of an established industry. In ordinary circumstances, it would continue to be limited in scope and might progress spasmodically with improvements in engines and producers until satisfactory results were achieved, but during war-time conditions, when the Government is prepared to do everything to encourage the practical application of ideas that have been evolved from long experience, and lorry and car owners have no choice in using a substitute for petrol, it may be assumed that concentrated attention on the problem of suction gas for road traction will smooth out its many difficulties and prepare the way for a practical solution.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ENGINEERING EDUCATION

Sir,—In your leader of September 29th entitled "Social Responsibility of the Engineer" you refer to Mr. Doherty's paper as follows:—"We are told that the American Engineering Council is withering for lack of support, and the reservation with which some engineering societies enter the Engineers' Council for Professional Development is noted" and "he censures the Teaching profession" for failures of duty "as a glance at engineering curricula will indicate."

The National Council of State Boards of Engineering Examiners was organised at a meeting held in Chicago in 1920 in response to a call issued by the Iowa State Board of Engineering Examiners. Seven States were represented. At this first meeting of the Council a Constitution was adopted containing the statement "that a permanent organisation be effected to carry out as far as may be practicable the uniformity of practice of examination and registration of engineers." It will be noted that the movement was of voluntary origin. The following year there were eight State representatives; the third year fifteen. At the nineteenth Convention there were twenty-six States represented and the membership of the National Council is now forty Member Boards, representing approximately 60,000 legally registered professional engineers and surveyors. The National Council or the National Bureau of Engineering Registration, which is a function of the Council, is named in the registration laws of 19 States and is therefore legally recognised in these States.

Here then is a system which bids fair to control the whole range of engineering examinations for the United States. It is a powerful testimony to what can be achieved when a small group of men of vision, actuated by disinterested purposes, set out for reform. The intention is that an examinee should feel that wherever he sits there should be some degree of uniformity in the test, some safeguards that his examination will not be more difficult in one place than in another.

At the sixth annual meeting of the Engineers' Council for Professional Development in 1938, which includes representatives of the National Council of State Boards of Engineering Examiners, Professor Scott, President of the latter body, said:—"Accrediting in engineering schools is acclaimed as the great achievement of E.C.P.D. They have been traditionally individualistic; they have been free to fix their own standards, loosely linked by voluntary association in the Society for the Promotion of Engineering Education. What agency was competent to appraise them? E.C.P.D. undertook the task. It has performed a miracle."

Well might Professor Scott wax eloquent. Up to 1938 of 679 curricula submitted, 392 were fully accredited, 107 accredited provisionally, and 179 not accredited.

Your article, following Mr. Doherty, suggests failure on the part of this system, whereas it has been a triumphant success. I agree with Mr. Doherty that professional men do not take by any means sufficient interest in problems outside their specialised function. In the larger aspect this is true, but it is true also in inter-professional relations, except where the shoe pinches as a result of competitive strife. This apathy accounts for the want of collective organisation of the professions. They lack that stimulus for improved wages and conditions that formed manual workers into protective unions and later into federations and an annual congress. You deplore the want of an organisation that can speak for engineering as a whole. I not only deplore that, but I deplore more the want of a federal organisation for the whole body of professions. Your view, like that of all *ad hoc* papers, is sectional. Rarely do I note any enlarged views in the technical press. Yet if there is one doctrine of paramount importance that has become increasingly manifest as time passes, it is the ever-growing interdependence of society whether in peace or war. So I entirely agree with Mr. Doherty in his vision of engineers "represented on an equal footing with other professions and councils of Government that might work out intelligent recommendations regarding long-range policy on which legislative bodies or administrations might act." It is in exact accord with my own views. I give to such a body the nomenclature "federal."

There is no argument that you use in your leader in favour of a general engineering council that is not equally cogent for the establishment of a federation.

For this purpose the Engineers' Guild is on a wrong basis. A federal body does not consist of members indiscriminately drawn from the various engineering bodies, who elect a council, but in representatives sent by each component institution to form a federal council to watch the interests of all these components, to remedy their separate grievances, to uplift their general standards, and thus generally to function rationally as sections of the community, and, supremely, to co-operate with all other sections of activity for the general well-being of the State.

A. W. Crampton, F.S.I.

2, Rowanhurst Mansions,
18, Canfield Gardens, N.W.6.

SCOTTISH LOCOMOTIVE EXPERIENCES

Sir,—I should like to say how much I have enjoyed the first two articles of Mr. Livesay's Scottish locomotive experiences. They are even better than his former ones, and are very different from the dry-as-dust logs of speeds, distances, and gradients, with the engine largely ignored, that one so often sees. I agree with another correspondent, referring to the previous series, in saying that I have read many accounts of footplate travel, but never any like Mr. Livesay's vivid descriptions. They are *alive*, and one can almost imagine being in the cab oneself.

In his accounts, the technical, constructional, and operational points are all combined in a way that is surely unique. At any rate, it is so far as my knowledge goes. The articles are most entertaining to an engineer such as myself, whose work has not been connected with locomotives, but who is nevertheless very interested in them.

Mr. Livesay's light and easy style takes all stodginess out of his writing, yet the facts are all there. He does not overlook the human element, and always gives the enginemen due credit, which is as it should be.

I am looking forward to Mr. Livesay's French experiences, and may I suggest that if he should re-cross the Atlantic, he will tell us something about the outstanding locomotives now running in America. I am sure he could find much material of interest there for readers of The Engineer. That is, of course, if the war permits. In any case, I shall always be pleased to see his contributions in The Engineer.

James Stokes.

Wembley, October 2nd, 1939.

Literature

SHORT NOTICES

The Elements of Radio Communication. 1939. By O. F. Brown and E. L. Gardiner. London: Oxford University Press. Price 16s.—The first edition of this book was published ten years ago, and since then far-reaching changes have been made in the art of radio communication. The changes in this second edition are therefore considerable. Contrary to the original arrangement, the thermionic valve, now a highly important device in wireless communication, is dealt with in the early part of the book. Everything possible has been done to retain those features which have led to the success of the first edition as a teaching medium. The original wording has been retained wherever it remains suitable, and in consequence of this paragraphs may be found in which the wording used is not most commonly employed to-day. Radio communication, the authors state, can only be understood if the historical stages which have led up to the present state are appreciated. Hence the ultra-short waves demonstrated by Hertz, now the latest development in television, are considered; also the original Fleming two-electrode valve. In view of the extent of new material calling for inclusion in the present edition of the volume, it has been impossible to aim at an advanced technical standard within the space available. Hence the volume remains an elementary text-book in which an attempt is made to introduce and explain all aspects of radio communication as a coherent whole, without resort to mathematics beyond that required for examination purposes. Every effort has been made to treat the subject comprehensively rather than at great depth. The valve chapter has been considerably extended and contains descriptions of special apparatus, such as the cathode ray tube and electron multiplier. The reader's attention has been directed wherever possible to future developments, and chapters have been added on television, both from its present aspect and from several unsuccessful attempts which have paved the way to the present results obtained. A chapter has also been added explaining the subject of aerial design, while references are also made to recent developments, such as aerial navigation by radio, ultra-short wave working, and the quartz crystal filter. The book is intended to cover the syllabus of the City and Guilds examination in radio communication, Grade I.

The Fundamental Theory of Arc Converters. 1939. By H. Rissik. London: Chapman and Hall, Ltd. Price 18s.—This book may be regarded as a companion volume to the author's work on "Mercury Arc Current Converters," written more for the student and operating engineer rather than for the designer or research engineer, and which consequently deals with rectifier theory in an elementary manner. The first and main part of this new book is devoted to the circuit theory of the normal rectifier, and although the main outlines of this theory are well known, the author has introduced a considerable amount of new matter which throws some light on the somewhat obscure inter-relation of the circuit quantities on the A.C. and D.C. sides of the apparatus, more particularly when the generation of harmonics is concerned. Part II of the volume is in a sense an extension of Part I, in that it is devoted to the generalisation of this theory, so as to include the case of artificially delayed commutation, a process known in mercury pool and hot cathode rectifiers as grid control. The author develops the general circuit theory of the grid-controlled rectifier and gives a brief account of the basic principle and methods of grid control. Part III of the volume may be regarded as being a special aspect of the second, in that it considers the particular case where the grid-controlled rectifier operates with a phase angle of retarded commutation lying between $\frac{\pi}{2}$ and π, corresponding to the inversion of D.C. to A.C. The last section of the book deals in part with the circuit theory of the invertor, which is expected to play an important part in connection with long-distance D.C. transmission. The concluding chapters are devoted to the theory of the grid-controlled cycloconverter or static frequency changer. The book constitutes a useful addition to the literature on arc converters, on which the author is a recognised authority.

Projected Exhibits at Olympia

No. V

(*Continued from page 361, Oct. 6th*)

BELOW we continue our description of some of the exhibits which were to have been shown at the Engineering and Marine Exhibition at Olympia, London, the holding of which has had to be postponed on account of the war.

ALFA-LAVAL COMPANY, LTD.

Amongst a wide range of lubricating and fuel oil purifiers, varying in capacity from 10 to 2400 gallons per hour, to have been exhibited by the Alfa-Laval Company, Ltd., there are two new equipments, which we illustrate and describe below. These new products comprise a self-contained turbine lubricating oil equipment, which is available in capacities up to 1600 gallons per hour and has a number of novel points designed to maintain cleanliness and provide against the risk of flooding and loss of oil, and also a range of smaller centrifugal oil purifiers, suitable for marine and land purposes and especially for oil engine plants, having capacities up to 40 gallons of oil per hour.

The design of the turbine oil equipment is shown in the accompanying half-tone engraving, Fig. 125, and the drawing, Fig. 126. The machine to have been exhibited is rated at 250 gallons per hour and is known as the 4024 type. It comprises a centrifugal separator, a driving motor, suction and discharge pump, a clean oil de-aerating tank, a water collecting tank, and an oil heater of the "indirect" pattern, electrically operated and thermostatically controlled.

The separator bowl is designed in accordance with the firm's previous practice and can be arranged to serve the triple purpose of purification, clarification, or positive washing, the necessary interchangeable parts being supplied with each machine. These bowls are self-draining and are made of materials which resist corrosion and erosion. In order to give ready access to the bowl the covers are made in aluminium alloy and are hinged to the frame, with an automatic clamp for retaining them in the open position during the bowl cleaning operation.

Taken directly from a horizontal end shield mounted motor, the drive eliminates belt or chains, and an automatic centrifugal friction clutch is incorporated so that the centrifuge is brought up to speed smoothly without an excessive starting current.

One or two pumps can be provided as necessitated by the position of the separator in relation to the turbine oil tank. These pumps are integral parts of the centrifuge and are gear driven from the cross shaft. The pump drives are within the body of the separator and consequently run in an oil bath. Ball bearings are used throughout and lubrication is automatic; there are no oil cups or grease lubricators requiring attention.

Oil inlet and discharge pipes are permanently connected to the lower stationary part of the separator so that no joints have to be broken when the covers are opened for inspection or cleaning. Furthermore, the clean oil and water discharge ports are provided with inspection glasses, which, whilst being clearly visible, are fully protected against breakage.

In the design of the base plate the new machine departs from standard practice, as it also forms a clean oil de-aerating tank having a capacity of approximately 22 gallons. This tank is fitted with a valve, float controlled and adjusted so that the clean oil remains in the tank for a predetermined period of time before being discharged.

A further compartment is provided in the bedplate into which the separated water is taken, and the tank top immediately above this chamber has a large drainage hole protected by a gauze strainer into which any surplus oil collecting on the tank top is drained. The contents of the bowl are also emptied into this tank before the bowl is cleaned. The water tank is fitted with an oil level pipe, which effects continuous discharge of the water, whilst any oil lying on the top of the water is periodically taken through the separator and in this way the oil is recovered. The third space in the base plate is arranged as a tool cupboard with hinged door, opening vertically and having an automatic catch. The base plate is extended at one end to take the oil heater.

The oil heater consists of a nest of tubes surrounded by a water jacket. The oil to be heated flows through the inside of the tubes and the space on the outside of the tubes is filled with water. Electric heating elements are situated in the water jacket so that they are not in direct contact with the oil and heating is even over the whole of the tube surface and at a comparatively low temperature so that there are no local "hot spots" and consequently there is no possibility of burning or charring the oil. The outlet temperature of the oil is automatically maintained at a temperature previously decided and depending upon the condition and grade of oil by means of an adjustable control device comprising a thermostat and special contactor switch. The heater contactor is combined with the motor starting contactor so that in the event of the last-named failing the electric supply to the heater is automatically discontinued. Furthermore, a double-pole double-throw switch is fitted permitting the temperature

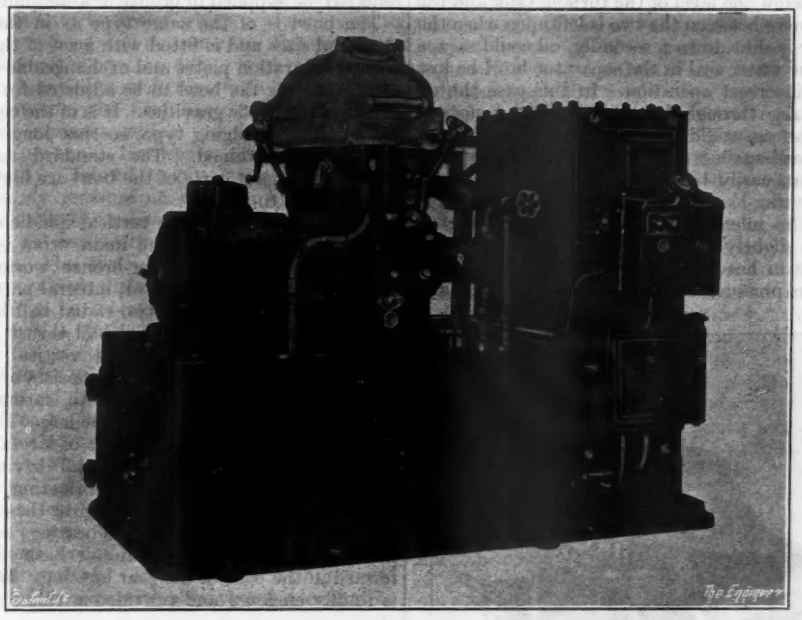


FIG. 125—TURBINE OIL PURIFIER—ALFA-LAVAL

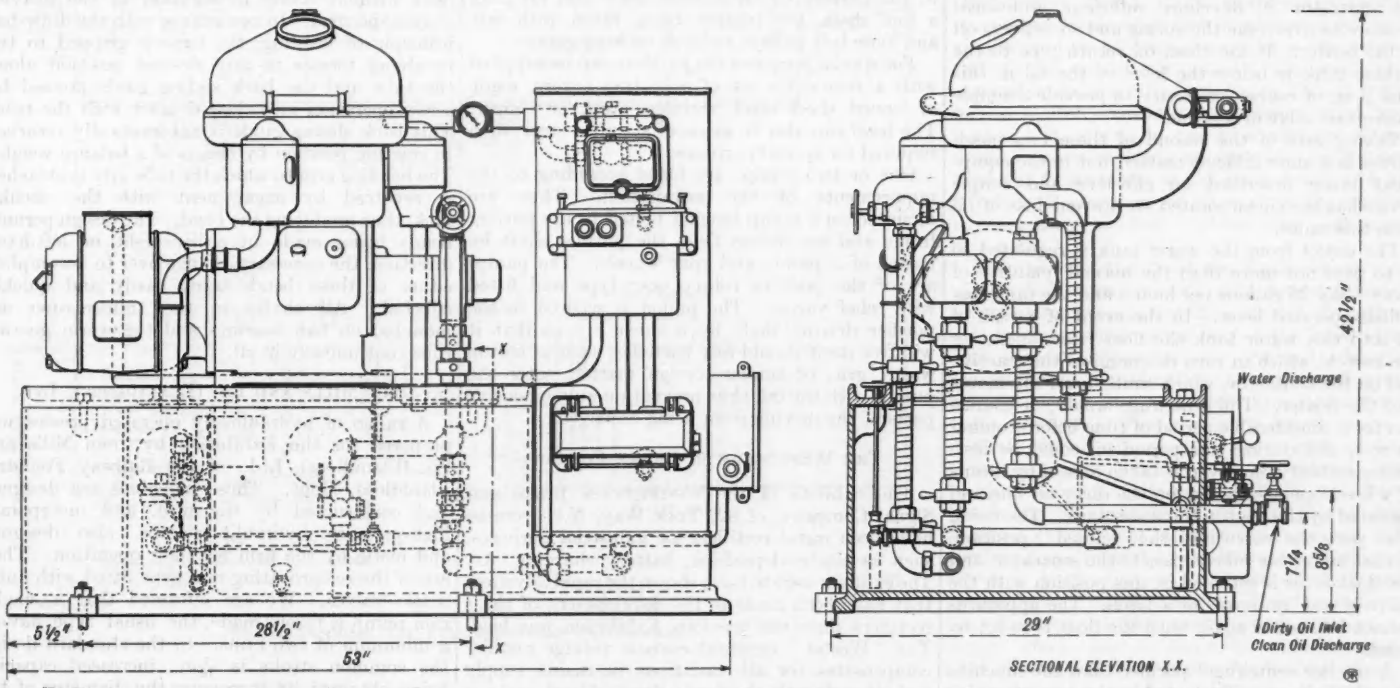


FIG. 126—GENERAL ARRANGEMENT OF OIL PURIFIER—ALFA-LAVAL

of the heater jacket to be raised before starting up the separator.

The heater water jacket is arranged so that a supply of hot water can be fed into the dirty oil line for sealing the purifier bowl or positive washing if necessary.

Neatly arranged, the pipe work is mostly situated inside the tanks. All oil and water connections are at the back of the equipment as are also the cable entries. The dirty oil inlet has a special protective strainer with a quickly removable basket. The controls, both electrical and mechanical, are on the front and grouped to one end. The oil feed to the purifier has a thermometer of the dial type with open scale.

There are stated to be two possible causes of oil flooding. Firstly, if the oil purifying equipment is below the level of the turbine tank and the control valve between the two is left open when the separator is shut down ; secondly, oil could escape should the water seal in the separator bowl be lost through incorrect operation. In this case the oil will discharge through the water port and, in normal circumstances, would go to drain with the water.

Safeguard against the first of these two possibilities can easily be taken, all that is necessary being a spring-loaded check valve on the discharge side of the inlet pipe with the spring set at a pressure slightly higher than that due to the difference in heads so that with the pump developing no pressure the valve remains closed and

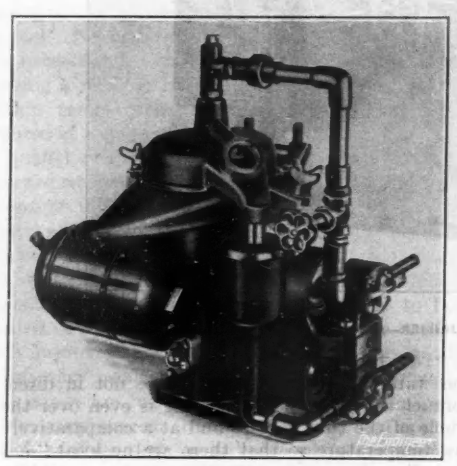


FIG. 127—SMALL OIL PURIFIER—ALFA-LAVAL

seals the line and when the pump is started up with the separator it develops sufficient additional pressure to overcome the spring and so delivers oil to the heater. If the clean oil return pipe to the turbine tank is below the level of the oil in this tank it is, of course, necessary to provide a simple non-return valve in this line.

Taking care of the second of these two possibilities is a more difficult matter, but in the equipment being described an effective and simple device has been incorporated to prevent loss of oil from this cause.

The outlet from the water tank is regulated so as to pass not more than the normal quantity of water—say 25 gallons per hour—and the tank has a float-operated lever. In the event of a rush of oil into this water tank the float rises, operating the switch, which in turn de-energises the tractive coil on the contactor, which shuts down the motor and the heater. The centrifuge would, of course, run for a considerable period of time before coming to rest, and during this period oil could be lost. This possibility, however, is taken care of by means of a lever-operated valve on the dirty oil line and operated by the float in the water tank. The rising float puts the valve into the " closed " position, so that no further oil can pass to the separator, and the float lever is retained in this position with the valve closed by means of a latch. The apparatus cannot be started again until the float is re-set by hand.

A smaller centrifugal purifier than the machine described above is illustrated in the accompanying half-tone engraving, Fig. 127. It is a new model, to have been shown for the first time, and is designed for use with small oil engine installations, both for land and marine service. The firm considers that such a purifier, especially for marine purposes, must be compact, robust, easily handled, and constructed to withstand the heavy rolling of a small sea-going vessel. The new purifier, known as the 1200 type, is claimed to comply with these requirements. Its capacity is up to 40 gallons of oil per hour.

Many of the points in design of the larger De Laval are included in this machine. One of the most noticeable of them is the arrangement of the cast covers, which are hinged to the separator frame and totally enclosed with exception of the water outlet, through which there is no risk of oil fumes escaping. The end of this outlet is, however, screwed, enabling it to be easily connected to discharge piping if required. The overflow, which indicates when the bowl is choked and requires cleaning, is provided with a sight glass, as in the larger types. The purified oil is discharged into a receptacle having a loose cover for inspection and sampling. The bottom cover, or water collecting vessel, is so shaped that thick emulsions, sludge, &c., can easily flow through the spout. The standard covers are made of cast iron, but can, if required, be supplied in bronze or aluminium alloy.

The bowl is of the same type as in the larger De Laval sizes and is fitted with a set of thin steel conical separation plates and exchangeable gravity discs, enabling the bowl to be adjusted for liquids of different specific gravities. It is of the constant-efficiency self-sludging type, so that long-running periods are obtained. The standard materials used for the main parts of the bowl are high-grade steel heavily tinned.

The bowl is carried on a vertical spindle of high-grade carbon steel and the main drive is transmitted through a phosphor-bronze worm wheel and a steel worm, which is an integral part of the spindle. The spindle has two radial ball bearings and at its lower end a special ball thrust bearing resting on a spring, absorbing vertical shocks, vibration, &c. The top bearing consists of a well-protected ball bearing fitted with spring-loaded horizontal buffers, as is used in the larger De Laval types, allowing a certain amount of lateral movement of the spindle. The horizontal driving shaft runs in two bushes of self-lubricating bronze, which eliminates the risk of leakage at these points. The worm gear and the spindle bearings are automatically lubricated from an oil bath which is formed in the base of the gear housing. This bath is totally enclosed and provided with an oil level glass.

The separator frame is of a compact and robust construction.

Four alternative arrangements of drive are available : (*a*) From a directly coupled flanged motor bolted to the purifier frame, as illustrated ; (*b*) from a directly coupled foot-mounted motor which is mounted together with the purifier on a common base plate ; (*c*) from a standard motor, which is mounted together with the purifier on a common base plate, the drive being transmitted to the purifier by an endless belt ; and (*d*) from a line shaft, the purifier being fitted with fast and loose belt pulleys and belt striking gear.

For special purposes the purifiers can be supplied with a removable set of collecting covers, made of tinned sheet steel, stainless steel, or copper. The bowl can also be made of stainless steel when required for special purposes.

One or two pumps are fitted according to the requirements of the installation. They are mounted on a pump bracket bolted to the purifier frame and are driven from the purifier shaft by means of a pinion and spur wheels. The pumps are of the positive rotary gear type and fitted with relief valves. The pinion is secured to the purifier driving shaft by a shear pin so that it will free itself should any particles, such as cotton waste, grit, or similar foreign matter, enter the pumps with the oil, thus preventing any expensive parts of the driving from being damaged.

The Westinghouse Brake Company

The exhibits of the Westinghouse Brake and Signal Company, of 82, York Way, N.1, were to have been metal rectifiers for industrial purposes, such as electro-deposition, battery charging, &c. The exhibits were to have shown the rapid advances that have been made in the development of these rectifiers since the previous Exhibition was held. The " Westat " constant current voltage rectifier compensates for all variations in mains supply and gives smooth, constant voltage of load, and has a high overall efficiency. It can be used to operate a constant potential floating battery system, and holds the battery potential within extremely close limits. If the battery becomes discharged it rapidly recharges at a predetermined maximum current until the floating voltage is reached.

A static phase converter which is very efficient has been developed. The equipment is small and inexpensive, and is suitable for use where three-phase current is required from a single-phase supply. It was to have been demonstrated in use by operating a variable-speed three-phase motor working from a single-phase supply.

Hilmor, Ltd.

Among the machines that Hilmor, Ltd., of 65, Calshot Street, London, N.1, intended to show at Olympia was the tube-bending machine illustrated in Fig. 128. It is capable of bending steel tube up to 2in. o/d by 10 G, and brass or copper tube up to 2½in. o/d by 10 G. The maximum radius of the standard machine is 8in. and the standard length of the mandrel rod is 4ft.

The machine is a self-contained unit arranged for direct motor drive.

Welded steel plate is used to form the body, which is so designed as to house the motor and transmission. The power required to drive the machine is 3 H.P., and it is transmitted by roller chain from a motor to a countershaft, and thence by a second roller chain to the input shaft of a sturdy worm reduction box, which has a vertical output shaft with a solid spur pinion. The spur pinion engages with a mild steel machine-cut circular rack, which forms the driving medium of the bending arm. Engagement of the bending arm with the revolving rack is obtained by means of a self-locking, lever-operated sliding block, meshing with the teeth of the rack. The machine is operated through a clutch, and the degree of the bend is predetermined by means of a variable stop. The bending arm is released and returned to the starting position by hand. This type of machine is equipped with the mandrel

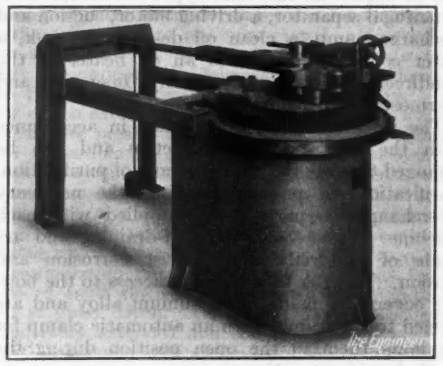


FIG. 128—TUBE BENDER—HILMOR

or draw-bar arrangement, which, it is claimed, enables exceptionally light-gauge tubing to be bent without filling in addition to the heavier gauges specified. In accordance with the draw-bar principle of bending, the tube is gripped to the revolving former in any desired position along the tube and the back sliding guide pressed by screw operation into close contact with the tube. This back sliding guide is automatically returned to starting position by means of a balance weight. The bending arm to which the tube grip is attached is revolved by engagement with the circular rack, thus producing the bend. The design permits bends being made in either right or left-hand direction, the necessary change over to accomplish either of these bends being easily and quickly effected. All shafts in the transmission are mounted on ball bearings and the worm gearing runs continuously in oil.

John Mills and Co. (Llanidloes), Ltd.

A range of hydraulically operated presses was prepared for the Exhibition by John Mills and Co. (Llanidloes), Ltd., of the Railway Foundry, Llanidloes, Mont. These machines are designed and constructed by the firm, and incorporate high-pressure hydraulic pumps, also designed and made by the firm for their operation. They are of the reciprocating ram type fitted with automatic valves. We are informed that a single-ram pump is rarely made, the usual type having a minimum of two rams. In the standard design the common stroke is $\frac{7}{16}$in., increased capacity being obtained by increasing the diameter of the ram, and by multiplying the number of rams used. The speed is designed to be varied from 1000 r.p.m. to 1500 r.p.m., against a maximum working pressure of 2 tons per square inch. Known as " Oilaulic " pumps, they are made in a range of eight sizes, of which the smallest requires from 2 H.P. to 5 H.P. for its operation, and the largest from 75 H.P. to 100 H.P., at 1460 r.p.m.

The cams actuating the ram are carried on roller bearings, there being a " Fescolised " roller race for each throw of the cams, in order to secure

a minimum of friction and consequent wear. The return stroke of the ram is spring-controlled. Low-pressure oil, supplied by rotors within the pump chamber, causes the main ram of the press to descend quickly until it comes into contact with the work piece; at this point the low-pressure supply is cut out by a relief valve and the full working pressure comes into action.

Heat-treated chrome-molybdenum steel is used for the pump body, the rams themselves being of chrome-carbon steel, heat treated to ball bearing

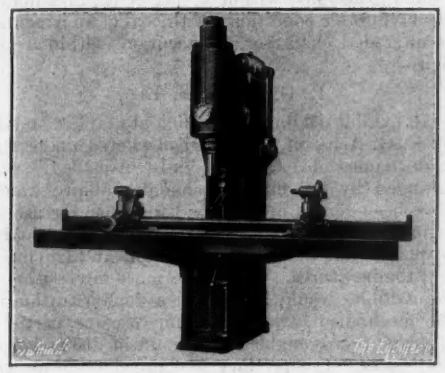


FIG. 129—"OILAULIC" PRESS—MILLS

hardness after grinding. A substantially designed, externally adjustable relief valve is provided; also, a hand control lever by means of which any desired pressure can be attained within the designed limits of the press.

The pump mechanism is entirely enclosed within a cast iron casing or tank containing the hydraulic medium, which also serves as a lubricant for the pump rams and other moving parts. Projecting through the casing is the cam shaft spindle, fitted with a flexible coupling for connection to the driving motor or pulley. The firm claims that the pumps are reliable in service and suitable for continuous duty. In the firm's "Oilaulic" presses, this design of pump is incorporated within the machine frame, but they are equally suitable for many other purposes, such as providing fluid under pressure for the operation of riveting machines, baling presses, furnace doors, heavy machine tool equipment, and so forth.

We illustrate in Fig. 129 one of the firm's "Oilaulic" presses, equipped with straightening gear. The vertical presses made range from 1½ tons to 200 tons capacity, in standard sizes. Other sizes outside this range can be supplied, but the standard machines are capable of performing a wide range of duties, including broaching bushes and similar details; compressing ends of tubes and metallic powders; riveting; bushing fly-wheels and fitting cylinder liners; straightening axles and shafts, and many kindred operations.

Cast iron frames are used for the small presses, having capacities up to 30–40 tons, but for large presses the frames are made of fabricated steel. The main hydraulic cylinder contained within the press frame is a machined steel forging. For the descending stroke of the ram oil pressure is used, but for the return stroke the ram is controlled by a powerful spring. We are informed that no hydraulic packing is necessary. Manual control and pedal control is provided.

It is sometimes important to be able to control the minimum pressure at which a press begins to exert its effect as well as to control the maximum pressure exerted on the job. With this object in view, especially with regard to the assembly of components, the firm has designed a special control equipment which can be fitted to the vertical presses. Known as the "Maxmin" control, it is claimed to give an absolute check by assembly pressure on machine limit gauging, by automatically rejecting slack assembly and equally automatically rejecting a too tight assembly. The controls are operated by adjustments contained within a locked recess, so that they cannot be interfered with after being set. Furthermore, a stroke-limiting control is provided, so that the position of the stroke at which the pressure limits become operative can be accurately predetermined. If required, a suitable dashpot control can be fitted to allow the press ram to dwell under pressure for a predetermined period.

In the drawing reproduced in the accompanying engraving, Fig. 130, is shown another of the firm's products, a horizontal press, suitable for use in shipyards, collieries, iron and steel works, and railway works for bending or straightening rails and girders. It comprises a horizontal power cylinder containing a heavy ram terminating

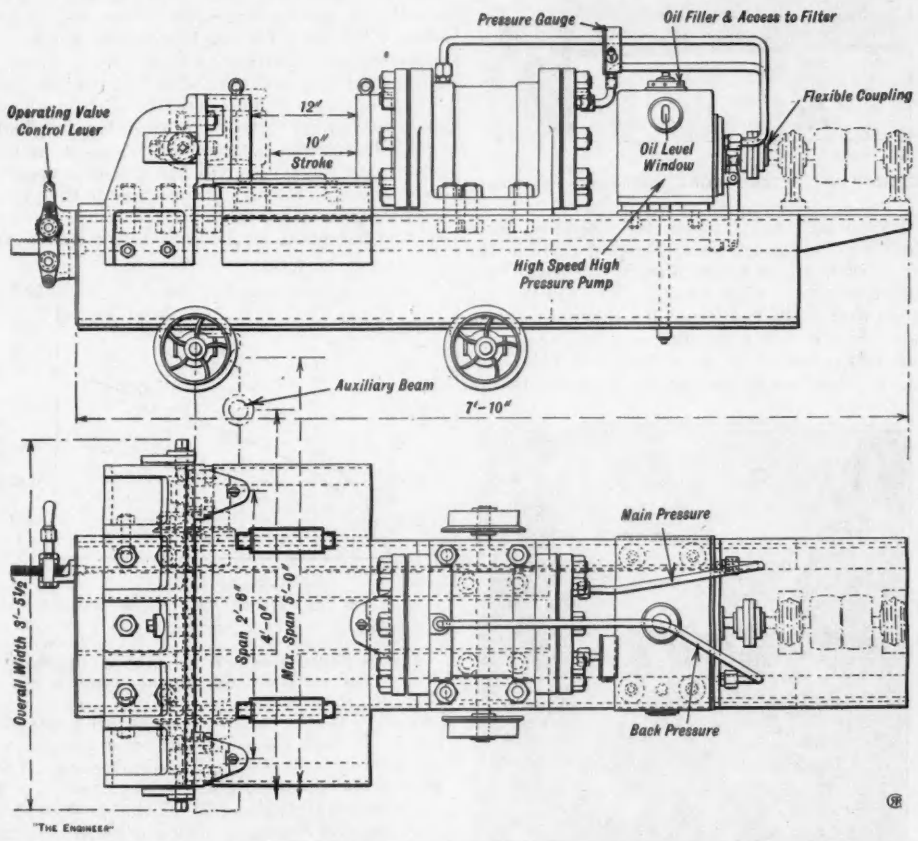


FIG. 130—BENDING OR STRAIGHTENING PRESS—MILLS

in a specially formed die-head, operated by the "Oilaulic" pattern pump, already described. These components are carried on one end of a substantial steel carriage, which can either be mounted on wheels, or bolted down to a permanent foundation. It is particularly pointed out, however, that no special foundation is necessary. On the other end of the carriage a heavy cross frame is fitted, carrying for bending operations two adjustable headstocks, or die-blocks, against which the rail or girder to be bent is placed. The distance separating the headstock blocks can be adjusted by means of a square-threaded screw operated by a crank handle.

INDUSTRIAL RESEARCH EXHIBIT

The Department of Scientific and Industrial Research would have presented an industrial research exhibit illustrating some of the work of the National Physical Laboratory, the Fuel Research Station, and of the following co-operative research organisations:—The British Cast Iron Research Association, the British Non-Ferrous Metals Research Association, the Iron and Steel Industrial Research Council, and the Research Committee of the Institute of Welding.

In the section which was to have been devoted to the exhibits of the National Physical Laboratory, apparatus was to have been shown for the measurement of creep or the progressive stretching of metals and alloys when heated under load—a subject becoming of increasing importance in engineering design. One of the most important individual exhibits would have been an example of the latest type of high sensitivity creep-testing machine designed by the National Physical Laboratory. The machine, which is one of twelve recently constructed at the Laboratory, is capable of measuring an average creep rate, over a period of a few hundred hours of about one hundredth of a millionth of an inch per inch per hour. The machine can apply a load of 5 tons to a test piece ¼ square inch in section heated by an electric furnace to the required temperature. A thermostat is provided to maintain the temperature of the test piece within $\pm\frac{1}{2}$ deg. Cent. The creep of the test piece is measured by means of mirror extensometers, telescopes, and illuminated scales.

Another apparatus of special interest deals with the method developed at the Laboratory for measuring the temperature of liquid steel. Although the quality of steel is believed to depend greatly on the exact temperature at which it is poured from the furnace, reliance has hitherto had to be placed on the acquired skill of individuals in judging this temperature, since no routine measurement of the steel when in the furnace has been practicable. Measurements on the steel after it has left the furnace are not of great accuracy and are taken when it is too late to apply temperature control. In the method devised at the Laboratory a thermo-couple is immersed directly in the steel while still in the furnace. Earlier attempts on these lines failed because the heavy sheathing believed to be essential for protecting the thermo-couple proved too expensive for routine work. The main feature of the new method is the use of a very light and cheap silica sheath which enables the thermo-couple to be plunged into liquid steel so as to give a reading of temperature in a few seconds and to be withdrawn intact. The method is applicable not only to furnaces of various types, but to molten steel at various stages after being tapped. It is now in use at a number of steel works. Other exhibits contributed by the National Physical Laboratory would have dealt with the "fretting" corrosion of closely fitting surfaces, the cracking of boiler plates and lubrication research.

Elsewhere on the stand the Radio Department of the Laboratory would have demonstrated in a very attractive manner the action of the cathode ray direction finder developed at the Laboratory. This type of apparatus was originally designed for studying the direction of arrival of atmospherics, but it is now a most important tool in radio research. The resultant signals from a distant station are received on a pair of loop aerials at right angles, and are caused, after passing through suitable amplifiers, to deflect the beam of electrons in a cathode ray tube similar to those used in television receivers. The electron pencil formed by the beam instantaneously traces a bright line on a screen of fluorescent material at the end of the tube. This line indicates the direction of the transmitting station. A model which was to have been shown would have illustrated the possible application of such an instrument to marine navigation. It represents the view from inside the chart room of a steamship. Away to the left is a lighthouse and to the right a lightship. Each of them is supposed to be transmitting signals, which are made visible by a light, and audible by a loudspeaker. The cathode ray direction finder registers the direction of arrival of these signals in turn on the screen of the cathode ray tube, which is graduated similarly to a compass dial. From the intersection of these two bearings the position of the ship is fixed as illustrated by an illuminated map. Ships

pass across the field of vision and one of them is also sending out wireless signals. The changing bearings of this ship as it crosses the field of view is also shown on the tube.

One of the most important sections of the work of the fuel research organisation of the Department of Scientific and Industrial Research is the physical and chemical survey of the national coal resources, the headquarters of which is the Fuel Research Station. One-third of the large stand which was to have been taken would have been entirely devoted to the work of the survey, which is providing for the first time an accurate chart of the potentialities of our immense coal reserves. The survey is telling coal producers the exact nature of their products and how particular seams are likely to vary from point to point in quality and thickness and is thus helping in their rational development. It tells consumers where they can obtain the particular type of coal they require and is giving information on the best sources of coal for special purposes. The survey is also assisting in the choice of coals for blending and is giving valuable information to those engaged in the cleaning of coal. The work of the survey is mainly carried out at nine laboratories situated in the different coalfields and the organisation covers practically every coal producing area in the country and work is in active progress in areas responsible for over 98 per cent. of our annual output of coal. The survey examines two distinct types of samples, namely, pillars representing the coal seam as it actually occurs underground; and secondly, commercial grade samples representing the commercial products of the industry under the actual conditions of mining and preparation adopted. The exhibit would have shown how, in sampling a seam in a mine, pillars are cut representing the entire thickness of the seam, how they are examined and how the samples are scientifically reduced to a bottle of finely powdered coal which may ultimately be representative of many million tons of coal. The exhibit would also have shown how the fifteen to twenty different analyses made on the sample are carried out. Some of the analytical apparatus used in the examination of a sample was to have been shown in operation.

Another section was to have been devoted to the work of the Research Committee of the Institute of Welding to which the Department of Scientific and Industrial Research contributes financially. The second year of the work of this Committee has just been completed, and much of the research in progress under its twenty-eight sub-committees and panels would have been illustrated. The exhibits would have dealt with the weldability of high-tensile structural steel and of non-ferrous metals, with the application of welding to ship structures and to frame structures, and with research on repeated stresses applied to welds. A specially interesting apparatus is a crack testing machine, which was to have been shown in operation. The equipment has been designed for comparing electrode deposits by bending during the welding operation, and thus under conditions immeasurably more severe than those likely to be met with in practice. The standard test enables direct comparison to be made between different types of electrodes.

The exhibit arranged by the Industrial Research Council of the Iron and Steel Federation would have dealt with recent research, aiming at improvement in the design of ingot moulds by determining the temperature conditions in the wall of a mould during and after the casting of an ingot. The British Cast Iron Research Association would have demonstrated some of the remarkable improvements in the properties of cast iron resulting from research. A model would also have been shown of the latest form of blast balance cupola developed by the Association. Over 200 furnaces of this type are now in service, and it is calculated that the saving in fuel resulting from their use represents a sum of more than three times the total annual expenditure of the Association. Finally, the British Non-Ferrous Metals Research Association would have illustrated recent work on the founding of aluminium and aluminium alloys, bronze, and nickel-silver.

The Lea Recorder Company, Ltd.

Products of the Lea Recorder Company, Ltd., of Recorder House, Cornbrook Park Road, Manchester, 15, which would have been on show at the Exhibition would have comprised mainly various types of coal-metering apparatus for steam plants, most of which would have been shown in operation. In addition, an example of the firm's boiler feed recorder, operating on the V-notch principle, and a special type of trade effluent recorder would have been demonstrated.

The coal-metering instruments made by the firm are suitable for measuring the amount of coal consumed by Lancashire, Cornish, Economic, or any other type of boiler fired by screw conveyor mechanical strokers. In general, the coal delivered by such stokers is proportional to the number of

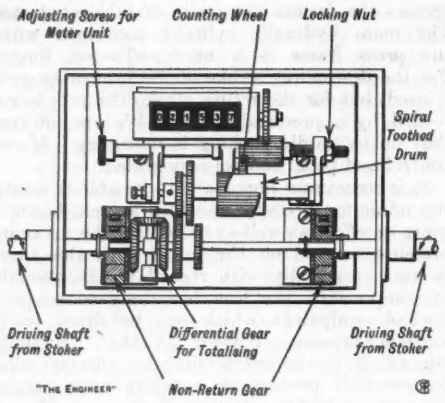


FIG. 131—"UNI-METER" COAL METER—LEA RECORDER

revolutions of the screw conveyor, and the principle upon which the firm's meters work is that of volumetric measurement, by means of a revolution counter, converted by an ingenious mechanism to units of weight. This type of instrument is known by the makers as a "Uni-Meter." A diagrammatic arrangement is shown in Fig. 131. In this case the meter is designed to sum the delivery of two

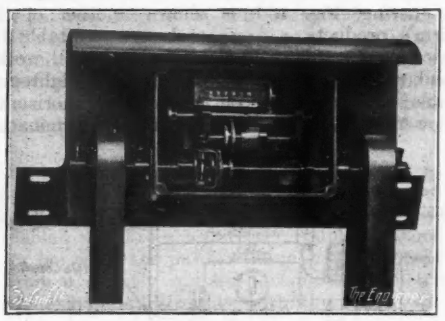


FIG. 132—"UNI-METER" COAL METER—LEA RECORDER

stokers firing two furnaces, for example, on a Lancashire boiler. Two shafts project from the meter, each driven independently by chains from the respective stoker shafts. The integrating mechanism takes the form of a differential gear, from which is driven through spur gearing a drum with teeth, cut off in spiral fashion. This drum can be clearly seen in the half-tone engraving,

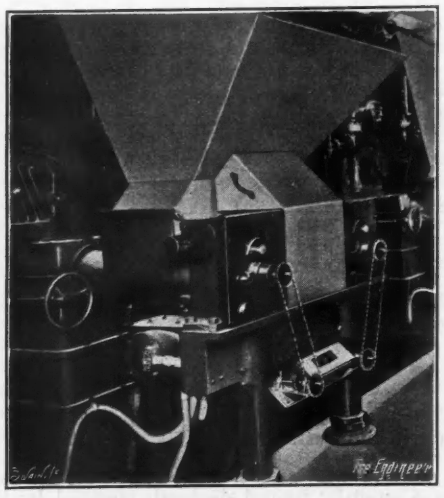


FIG. 133—COAL METER INSTALLATION—LEA RECORDER

Fig. 132. The drum is arranged to drive a pinion, which can be adjusted endwise so as to gear with a greater or lesser number of teeth on the drum. From the pinion the counting mechanism is driven. It will therefore be clear that by adjustment of the pinion, according to the density of the coal, the meter can be calibrated to read in definite integral numbers; for example, pounds or hundredweights of coal.

In Fig. 133 is illustrated a Lancashire boiler fitted with a mechanical stoker supplied by Hope's Heating and Lighting Company, Ltd., upon which a Lea coal meter is arranged in the manner described above. Should the meter be required for use with one furnace only, the integrating differential mechanism is, of course, unnecessary, and a simpler design omitting this portion of the mechanism is available.

With regard to accuracy, the firm guarantees under ordinary circumstances with a fairly uniform size or grade of coal the meters to give the true volume consumed within 2½ per cent., and under less favourable conditions, with coal of an irregular or ungraded character, an accuracy within 5 per cent.

E. G. Acheson, Ltd.

An exhibit dealing with colloidal graphite, made by E. G. Acheson, Ltd., and marketed under the trade names of "Oildag" and "Aquadag," was arranged by the firm. Colloidal graphite would have been shown in various dispersions for use as an industrial lubricant. It is claimed that colloidal graphite reduces wear and friction at high loads and temperatures. One of the most interesting of the exhibits would have been a demonstration of the mechanism whereby submicroscopic particles of graphite are enabled to remain in dispersion in lubricants. The product is claimed to be of use in the assembly and running-in of industrial equipment of all kinds, such as oil, petrol and gas engines, reduction gears, compressors, and the continuous lubrication of high-temperature equipment.

In support of these claims the firm refers to tests carried out by the National Physical Laboratory, which indicate that colloidal graphite increases the seizing temperature of an oil, permits the oil film to withstand higher bearing temperatures, enables the feed of lubricant to be reduced and minimises the possibility of seizure. Where seizure is imminent in a bearing the temperature will rise to a high value, and often an oil will be carbonised by reason of the high localised temperature. The fact that colloidal graphite delays seizure under these conditions shows that lubrication is maintained, at least temporarily. The use of this adjunct lubricant for the lubrication of kiln and annealing car bearings, and of oven chains is another indication of its value at high temperatures.

There is thus evidence to show that colloidal graphite is an effective lubricant for a cylinder zone. In internal combustion engines it may be passed into the cylinder by the use of a graphited crank case oil. It may also be added to the petrol, when the minute particles of graphite are drawn in by the induction stroke and swept on to the

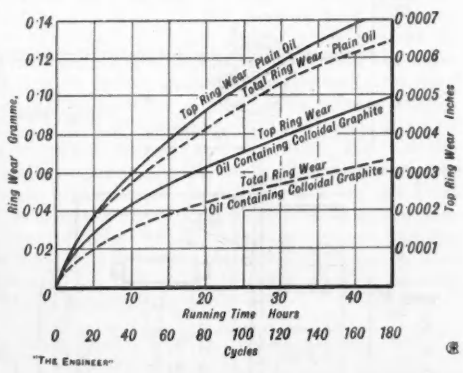


FIG. 134—INFLUENCE OF COLLOIDAL GRAPHITE ON PISTON RING WEAR—ACHESON

friction faces, the inlet valve stem being also lubricated. In both cases a reduction of wear is to be expected in both new and run-in engines. A test carried out by the Research Department of the Institution of Automobile Engineers has shown that sump oil containing colloidal graphite reduces cylinder wear by one half in a new engine in which repeated cold starts were made. The graph reproduced in Fig. 134 shows the results of tests on the effect of colloidal graphite on piston ring wear. While the major factor in the tests contributing to wear might have been other than high temperature, the value of colloidal graphite at cylinder temperature can be inferred.

Atlas Preservative Company, Ltd.

Two interesting products of the Atlas Preservative Company, Ltd., of Fraser Road, Erith, Kent, would have been shown at the Exhibition. Elasticity is an important property in a paint intended for the protection of iron and steel

structures. Without it, a paint film will crack and peel under vibration and strain, or in consequence of the movement of the metal because of temperature changes. A paint made by the firm, known as Atlas "Ruskilla," is claimed, by reason of a special medium employed in its manufacture, to grip iron and steel tenaciously, forming a tough elastic film resistant to the attack of fumes, steam, moisture, and exposure to the weather. The material is said to be applicable in many ways in ships, engineering works, and foundries. It is made in black, white, aluminium, and a number of colours.

In order to demonstrate the elastic properties of the paint, several models would have been shown. One of these models consists of an actual film of paint, stripped from a prepared metal plate, and arranged vertically between two clamps. The paint film is then subjected continuously to twisting, first a double turn to the right and then a double turn to the left. We are informed that the paint film which was to have been shown at the Exhibition had already withstood more than one million turns without disruption.

The other main exhibit would have demonstrated the firm's degreasing process, for which a model condenser (Fig. 135), consisting of a nest of tubes housed in a clear glass cylinder, had been constructed. The tubes were to have been coated with heavy grease and then degreased by means of a vapour process, claimed to give a thorough and rapid cleansing action. The process is claimed to be particularly suitable for freeing all grease from oil coolers, condensers, feed water and fuel oil heaters, exhaust gas turbines, and similar plant, in a period stated not to exceed eight hours.

Operated under licence from Imperial Chemical Industries, Ltd., the system uses trichlorethylene as a solvent. In the case of marine work, the firm undertakes to perform all the work and supply the equipment and solvent. It is pointed out that by this method the cleansing of the plant can usually be competed within a single day of eight hours, including fitting up and dismantling.

Briefly, the treatment consists of enveloping the surfaces to be degreased with the vapour of the solvent, then producing condensation. For example, in the case of a condenser in a steam plant, a vaporiser is connected to the empty condenser at the lowest and most convenient point possible. The solvent is heated by steam coils or electrically, and reaches its vaporising temperature at 186 deg. Fah. The vapour ascends and on reaching the cold tubes, condenses, and the reliquefied solvent dissolves

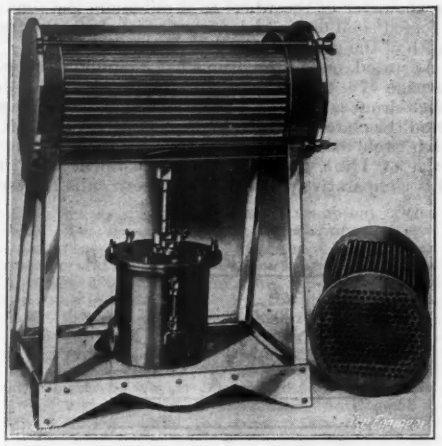


FIG. 135—MODEL CONDENSER FOR DEMONSTRATING DE-GREASING—ATLAS

and removes grease deposits. Dropping back, the grease-charged liquid is revaporised, but the grease, having a much higher boiling point, remains in the vaporiser sump, and is not, therefore, redistributed. After a suitable interval, the vapour reaches a point above the top row of tubes, whereupon steam is shut off and cold water circulated through the condenser tubes to induce condensation. The vapour then condenses very rapidly and washes away the remaining grease.

(To be continued)

An A.C. Electric Winder on the N.E. Coast

AN old steam winder at the Witton pit of the Charlaw and Sacriston Collieries Company, Ltd., Durham, has been replaced by a modern equipment, shown in Fig. 5. The steam winder, which had given faithful service for a century, consisted of a parallel drum mounted on the top of an "A" framework and driven by a single-cylinder engine directly below it. By working the valve gear by hand, watching the stroke of the piston and changing over the valves at the correct instant the driver controlled the engine at a position below the drum. As this old plant was obviously unsuitable for conversion to electrical operation, it was decided to replace it by an entirely new B.T.H. electric winder. A new engine-house was necessary, and as the only possible position for it was in the hillside behind the old engine-house, the construction presented some difficulty. Preparation of the new site involved the removal of some 2000 tons of material, mostly rock, although owing to an outcrop seam being encountered during excavation, a certain amount of coal was included. The building of the new engine-house with ample windows and rooflights was carried out by the colliery company, the foundations for the winder being built to the recommendations of Robey and Co., Ltd., who, acting as sub-contractors to the British Thomson-Houston Company, supplied the mechanical parts. To avoid any possibility of error in the final construction a model of the foundation was first made.

At the Witton pit three levels are being worked: Low Main at 243ft., Hutton at 318ft., and Busty at 602ft. The output from the three levels is 90 tons per hour. The new double parallel drum winder has one drum arranged with a clutch to facilitate changing levels. Driven at 34 r.p.m. through reduction gearing by a B.T.H. induction motor having a speed of 418 r.p.m. and peak rating of 490 H.P., the drums are 9ft. in diameter and 3ft. 1in. wide. The motor is a three-phase slip-ring machine, continuously rated at 245 H.P. and is wound for 2750 volts. It is of welded construction with bracket type end shield bearings. The end shields, which are spigoted to the motor frame, are split across the centre and carry brackets on which sleeve pedestal bearings are mounted.

This construction offers the advantage that as the motor is a complete unit it need only be lined up as a whole and there is no need to line up separate bearings before coupling to the pinion shaft, an advantage of particular importance where only a limited time is available for changing over from steam to electric driving. Bearings are lubricated by oil rings and the bearing liners are split, so that it is easy to remove the caps from the bearing housings and replace the liners if necessary without dismantling the machine. Wide spacing of the motor feet results in a very steady machine.

Current for the motor is obtained from the main oil circuit breaker through high-tension air-break reversing contactors, to be seen in Fig. 6, the closing coils of which are operated by D.C. obtained from copper oxide rectifiers mounted on the contactor framework, the supply to the rectifier being obtained at 625 volts from the secondary of an auxiliary transformer. By operating the contactors with D.C. a relatively soft closing is obtained and the tendency to hum is eliminated. Hence the contactors require less attention than they would do if fitted with A.C. operating coils. By operating the driver's control lever, which actuates a master controller through which the stator reversing contactors are energised, the winder is started and stopped. Speed is controlled by a liquid controller in the motor rotor circuit operated by an automatic accelerating device. This device consists of a motor-driven oil pump supplying a servo motor, and the maximum acceleration can be predetermined by the setting of the device. Slower acceleration is obtained by manipulation of the control lever. Provision is made for lowering men, when necessary, to the full depth with reverse current braking.

All the safety devices on the winder operate through the low-voltage release on the main oil circuit breaker. When any device is operated, it opens the low-voltage coil circuit to trip the circuit breaker, and thus cuts off power from the winder motor and applies the brakes. Reliance is not placed solely on the low-voltage release of the main circuit breaker, for cutting off the supply and applying the brakes in the case of emergency, but a safety contactor is also provided. This contactor has its coil in the safety circuit in parallel with the coil of the low-voltage release, so that both coils are de-energised together. As the supply to the brake solenoid and to the operating coils of the reversing contactors is taken from the contacts of this safety contactor, the results of opening the latter are that the supply is cut off from the winder motor (owing to the opening of the main reversing contactors) and the brakes are applied by reason of the brake solenoid being de-energised.

On the depth indicator, two overwind prevention limit switches are mounted. The backing-out switch, for backing out after an overwind, is a drum switch mounted on a cast iron pedestal, with the driver's emergency switch in a convenient position on the driver's platform, shown on page 376. This switch enables the driver to back out confidently and correctly, after an overwind, the connections of the switch being so arranged that it is impossible for the driver to move the cage further into the fault, even if the controller is moved in the wrong direction. After backing out, the switch should be reset, but if by any chance it should be left in position, a complete trip can still be taken with safety, as the other overwind switch has not been rendered inoperative.

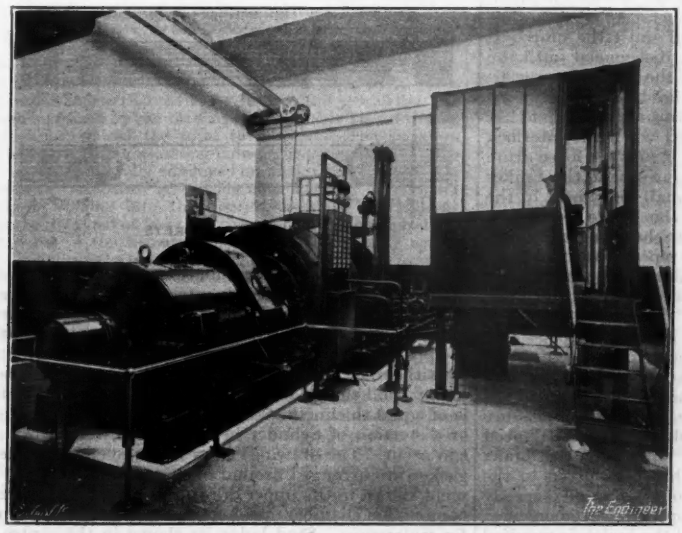


FIG. 5—GENERAL VIEW OF ELECTRIC WINDER

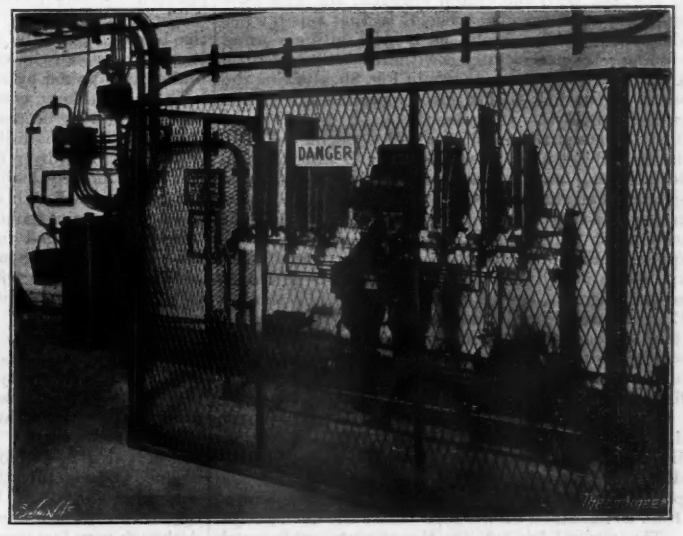


FIG. 6—AUXILIARY TRANSFORMER AND REVERSING CONTACTORS

Subsequently the interlocking system makes it impossible to carry out further winds until the switch has been reset.

Overwind protection, apart from the limit switches on the depth indicator, is provided by the Lilly controller shown on page 376, which also provides overspeed protection, and is arranged to comply with the new landing speed regulations, thus ensuring that men cannot be landed at a speed more than 5ft. per second. Fitted with duplex governors, it is of the special loose dial type, and makes it possible to land coal at a higher speed than that possible when landing men. Often the new landing speed regulations impose such severe restrictions at the end of the wind when winding men, that if no alteration is made for coal winding conditions it is very difficult to obtain the requisite coal output, but the duplex governor arrangement overcomes the difficulty. The loose dial feature allows a single Lilly controller to be used on a winder with two drums, one fixed and one clutched. While one dial of the Lilly controller is gear driven from the fixed drum, the other is driven from the loose drum. Hence the dials are always in fixed relationship to the winder drums. In this case limit switch cams are fitted to both ends of both dials, so that protection is provided for both top and bottom of the shaft for each drum independently.

A B.T.H. patented device known as the "loose drum protective device," shown in Fig. 7, has also been supplied. It is arranged so that in the event

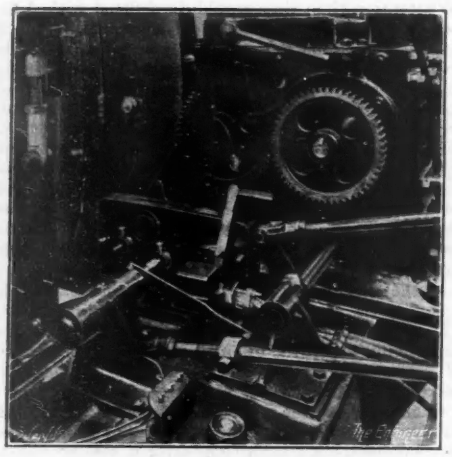


FIG. 7—LOOSE DRUM PROTECTIVE DEVICE

of the loose drum starting to slip when it is declutched and braked, the safety circuit is tripped, thus causing emergency braking to be fully applied on both drums. Not only does this ensure sufficient braking force being applied to arrest the slipping drum, but it also prevents any further operation of the winder until the fault has been rectified.

When the clutch is in, the loose drum protective device must be disengaged and engaged when it is out. It must be capable of being engaged for any position of the drum, and must then only operate when the loose drum begins to move. These requirements rule out any simple limit switch and cam arrangement, because if the limit switch were brought into contact with the cam when the drum is declutched the cam might be in any position, and in such a position as to trip the brakes straight away. In Fig. 8 is shown the device employed. The excentric A is operated by the clutch mechanism, and when the clutch is engaged is in the position shown in Fig. 8a, whilst when the clutch is disengaged it is in the position shown in Fig. 8b. The ratchet wheel C is driven by the loose drum of the winder, and in the present case by a chain and sprocket wheel. In Fig. 8a, with the clutch engaged, the link B is held clear of the ratchet wheel C, so that this ratchet wheel can revolve freely, as it will during normal winding. When the clutch is withdrawn, the excentric A takes up the position shown in Fig. 8b, allowing the pin E of the link to fall into engagement with the ratchet wheel C. If, now, the loose drum should start to move, the ratchet wheel C begins to turn, the link B is pulled over, the lever D falls over its dead centre, and by its own weight operates the lever K of the limit switch L, and this opens contacts in the low-voltage circuit of the main switch, thus tripping it and causing emergency braking to be applied. Fig. 8c shows the new position now taken up, where it will be seen that the link B now rests on shoulders on the ratchet wheel C, while the pin E is thrown clear of the wheel teeth, this ensuring that no damage is done to the device while the winder drum is turning the wheel C before it is finally stopped. By means of the lever R rigidly fixed to the link B, the device is reset by hand.

As the loose drum can only start to slip in one direction, the device is uni-directional in operation. But if bi-directional should ever be required, two devices can be used, one for each direction. In the present case the loose drum can only slip about 12in. to 18in. as measured on the rope before the device trips.

The general lay-out for the winder, cable work and the erection of the electrical equipment were carried out by the B.T.H. Company. Mechanical parts were manufactured by Robey and Co., Ltd., acting as sub-contractors to the B.T.H. The driver's cabin was erected by the colliery company from standard Crittall glazed partitions. The drum shaft is composed of 30–35-ton tensile forged steel, whilst the drum sides are of cast iron with steel plate barrels grooved from the outside edge of each drum to a point past the head gear pulley centres, to facilitate the even coiling of the ropes. A B.T.H. spring type flexible coupling and a double helical gear-box with a ratio of 12·2 to 1 are employed to connect the motor to the drum shaft. To keep the diameter of the wheel to a minimum the pinion is forged solid on its high carbon steel shaft, the face width of the gears being 16in.

As stated, one of the drums has a clutch, as shown on page 376, to facilitate changing levels, while the other drum is secured to the shaft. For the loose drum the clutch is of the multiple tooth type, with a pitch circle diameter of 16ft. 6in., the teeth having a pitch of 1¾in., giving a rope adjustment of 2½in. This comparatively fine pitch of teeth calls for very

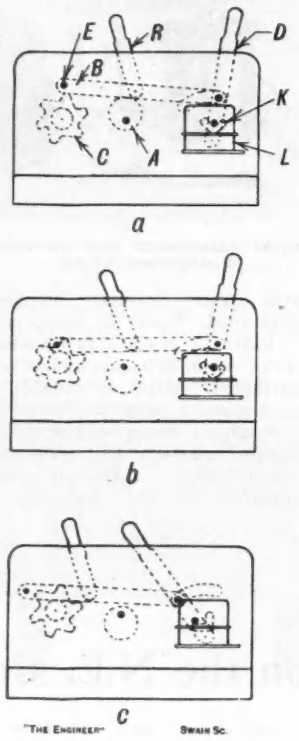


FIG. 8—DIAGRAM OF LOOSE DRUM PROTECTIVE DEVICE

accurate machining to ensure that the moving portion of the clutch will readily engage with the fixed toothed portion on the drum for any relative position of the teeth, and that all the teeth will take an equal share of the load. The clutch is operated by a double-acting oil clutch engine, which obtains its pressure supply from the oil accumulator supplying the oil brake engine. Only at infrequent intervals is the loose drum declutched, and hand screw-down gear operated from the driver's platform is provided to hold the brakes on the loose drum when free. The fixed drum brakes are then operated in the ordinary way by the oil brake engine when winding unbalanced. One pair of suspended post brakes is provided for each drum, and when both drums are engaged both brakes are operated simultaneously from the driver's platform. Mechanical interlocks are provided between the brake gear and the clutch operating gear, so that the brakes cannot be taken off until the clutch is engaged, nor can the clutch be disengaged until the brakes are applied by means of the screw-down gear.

In the unlikely event of the brakes not being adjusted, having become worn to such an extent that the brakes are not fully applied when the interlock is free, the loose drum might slip, and the loose drum protective device described ensures that the brakes are fully applied with a very small movement of the drum. The pins connecting the brake posts and levers are arranged for remote lubrication. They are all connected by means of pipes to a convenient position and fitted with Tecalemit grease nipples, thus ensuring that the less accessible pins can be readily lubricated.

A view of the brake engine is given on page 376. It is oil operated and totally enclosed, a design which obviates the necessity for packing glands on the pressure cylinder, thus minimising friction. Dead-weights apply the braking force, while the oil pressure is employed to take the brakes off. A balanced piston valve is employed for operating the brake engine, and careful attention has been given to the connections from this to the solenoid to give speedy application of the brakes when operating in emergency. Although very fast operation of the brakes is required towards the end of the wind, it is undesirable to have the same speed of brake application of the brakes when working at full speed. Fast and slow braking is therefore provided, giving delayed action of the brakes in the middle of the wind, and unrestricted speed of braking towards the end of the wind. This is accomplished by a regulating valve in the exhaust from the brake engine. The opening of this valve is regulated from the Lilly controller, and the valve can easily be set to give any delayed rate of braking, while towards the end of the wind it is gradually opened to the full extent to give rapid application. Should emergency application of the brakes be necessary in mid shaft, owing to overspeed or any other cause, the delayed application of the brakes obviate any shocks to men riding or to the equipment, while rapid application occurs after the Lilly controller has compelled the driver to reduce his speed considerably. For supplying the pressure oil to the accumulator, there are duplicate motor-driven oil pumps of the double helical gear type, which supply the brake and clutch engines. Each of these pumps is of ample capacity, and only one is in use at a time, the other being used as a standby to ensure continuity of service when maintenance, cleaning, &c., are required.

A summary of the main particulars of the winder equipment is given below :—

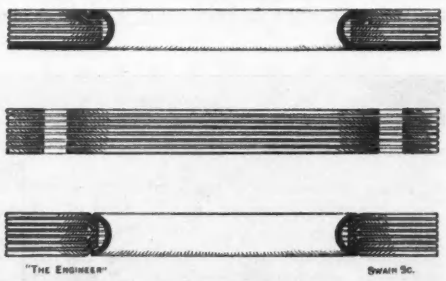
Motor :	
R.M.S. rating	245 H.P.
Peak rating	490 H.P.
Speed	418 r.p.m.
Rope :	
Size	1¼in. diameter
Weight	2·48 lb./foot
Maximum speed	16ft./second
Drum :	
Diameter	9ft.
Width	3ft. 1in.
Weights :	
Cage	4480 lb.
Tubs per cage (four)	1568 lb.
Coal per cage	3472 lb.
Stone per cage	5372 lb.
Winding times (for maximum depth) :	
Accelerating time	7·5 seconds
Full-speed time	30·2 seconds
Retarding time	7·5 seconds
Net winding time	45·2 seconds
Decking time	25·0 seconds

All parts of the winder are suitable for a future increase in the loading without alteration. The expected increase in loading involves four tubs of total weight 1792 lb., coal 4256 lb., and stone 6272 lb., in place of the figures given above.

The new winder has given a very satisfactory performance since its installation. It is cheaper to run than the old steam winder, and it is hoped to recover its cost in about five years.

Laminated Gaskets

THE accompanying drawings illustrate forms of laminated gasket made and supplied by Howard Clayton-Wright, Ltd., of Stratford-on-Avon. The "Dickson" gasket, as it is named after its inventor, consists entirely of a number of laminations. The metals used can be varied to suit the particular type of engine concerned. Sometimes, as in marine and aircraft engines, copper laminations only may be used. In other cases combinations of two metals may be employed. In oil engines, for instance, a combination of copper and terne plate has been found advantageous. The latter material consists of cold-rolled steel annealed and coated with an alloy, 80 per cent. lead and 20 per cent. tin. Copper-aluminium



LAMINATED GASKETS

and aluminium-terne combinations have also been used. Many important advantages are claimed for these gaskets. It is said that once properly fitted the gaskets will maintain a perfect seal, hot or cold ; that the pressure to maintain the seal need not be as great as with other gaskets ; that no cement or adhesive of any kind should be used ; and that since a gasket is of equal thickness over its whole area, no cracking or distortion of cylinder heads, flanges, blocks, &c., can occur. The drawings show how the edges of the gasket are arranged around openings. The arrangement shown in the upper drawing is that adopted for combustion chamber openings and that at the bottom for waterways. Stud holes, as shown in the centre, are driven straight through the laminations.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

Trade with the Argentine

The Report on Economic and Commercial Conditions in the Argentine Republic, published by H.M. Stationery Office, price 3s. 6d. net, contains some information which should be of considerable value to the British iron and steel trades in normal times. It covers the period from April, 1938, to June, 1939. In 1938 the imports of pig iron fell to 28,235 tons compared with 52,106 tons in 1937. This decrease was not due to any fall in the demand, but to the fact that the imports in 1937 were unusually high, as the foundries anticipated difficulties in obtaining supplies from Europe and doubled their purchases. The stocks accumulated in that year are being gradually liquidated and consumption tends to increase. Russia did not compete in the Argentine and the bulk of the demand was met from France, as the Belgian prices were too high. The imports from Great Britain consisted chiefly of better quality pig iron. It is pointed out that a new competitor has arisen in Brazil, a country which for many years prohibited the export of pig iron, and her re-entry will probably chiefly affect British exports, as Brazilian hematite pig iron is of first-class quality and much cheaper than the British product. In March, 1937, it was quoted at 100s. per ton c.i.f. Buenos Aires. During 1938 the greater part of Argentina's requirements of iron and steel products was supplied by Continental producers. The demand for structural steel fell away in that year and there were few important contracts placed for structural work, although those for similar work of minor importance were fairly numerous. With the exception of joists up to 16 cm. in depth, produced by a local firm which worked at full capacity throughout the year, Continental products dominated the market, as their price was much below the British quotations. The imports of steel plates were principally from Belgium, Luxemburg, and Poland. The demand for steel in sheet and strip form continued to expand in the period under review. Great Britain supplied a considerable tonnage of black sheets in the medium qualities for use in making steel furniture. The imports of black sheets for galvanising declined in 1938 owing to the large stocks which had accumulated in the previous year. Part of the substantial business hitherto held by British manufacturers was lost to Continental mills. Highly-finished cold rolled sheets were imported from the United States. Since the prevailing duties make it practically impossible for foreign firms to compete with the imported black sheets galvanised locally, the chief business effected in galvanised sheets was with Government Departments and such entities as were allowed to be imported duty free. Certain qualities of tank sheets were, however, imported from Germany. Poland was the chief competitor with prices anything up to £2 per ton below those quoted by the British makers.

The Pig-Iron Market

The situation in the pig-iron market has improved, as firms have become more accustomed to carrying on their business under Control conditions. The demand for all classes of pig iron has broadened, and there has been a noticeable improvement in the volume of business in high phosphoric iron. Before the war this description was in poor request as it is principally used by the light castings industry. The latter foundries are now engaged to a greater extent upon war work, and are absorbing larger quantities of high phosphoric brands. There are, however, good supplies available and deliveries can be obtained without much difficulty provided a licence is held. The expansion in the demand has spread to Cleveland No. 3 foundry, and more business has been transacted in this department of late than for some time. A considerable proportion of the quantities taken up are going into consumption on Government contracts, but there has also been a fair amount sold for commercial requirements, and the makers are apparently in a position to give reasonable delivery for this class of work. There has been no change in the price of Cleveland No. 3 foundry, which is quoted at 99s. d/d Middlesbrough and Falkirk, and 102s. d/d Glasgow. In the Midlands, whilst there has been more activity in the purchase of high phosphoric grades, the demand remains principally for low phosphoric iron. As a result of certain furnaces being put on to the manufacture of steelmaking irons, low phosphoric pig iron is not now so easily obtainable, and consequently a considerable tonnage of orders has been diverted to the hematite makers. The quotation for the former quality has advanced and it would be difficult to place an order at less than £5 15s. In Scotland production has been increased by the blowing in of another blast furnace, which has raised the total to fourteen. The situation in the Scottish light casting industry is irregular, but some of the firms are fully employed on work which is indirectly for war purposes. A considerable tonnage of Midland iron is coming into the district, as these descriptions can be obtained at less than the price of the local product. Business in the hematite market has been fairly active as specifications against contracts are coming forward freely. There is, of course, an insatiable demand for basic iron, large quantities of which are passing to the steelworks. There appears, however, to be no shortage and the works are receiving regular deliveries.

Scotland and the North

The change over from peace to war conditions in the Scottish iron and steel industry has taken place with much less disturbance to ordinary trade than might have been expected. The control of the industry and the classification of orders has proceeded smoothly, and although there is a certain amount of delay in the execution of commercial business, a fair amount of this class of work has been put in hand and, in some instances, deliveries have been made more rapidly than the buyer expected. Export business has naturally suffered from the prevailing conditions, not the least of which is the scarcity of available tonnage for particular destinations. Manufacturers appear to be more intent upon working off orders in hand previous to the outbreak of war than in accepting new business. During the past week, however, there has been less export business offering than during the period immediately following the declaration of war, and apparently overseas buyers have either reconciled themselves to waiting for an opportunity to obtain their requirements, or the first panic buying through fear of an interruption to supplies has passed. If anything, the pressure upon the steelworks has increased of late and the demand for all classes of steel, principally for work for national purposes, has expanded. The works have been operating at capacity for many weeks now, and all the possible plant has been brought into commission. The requirements of structural steel are particularly large. The shipyards are fully employed and large quantities are steadily passing into consumption in that direction. The demand for many descriptions of steel from the marine engineering and general engineering departments is at a high level and shows signs of increasing. Plates which a little time ago could be obtained fairly easily are now much more difficult to acquire for reasonable delivery. In the Lancashire market the call for joists and sections is unrelaxed, although some of the constructional engineers say they are less busy than before the outbreak of war owing to the decline in the volume of general commercial work. Business in bars, particularly reinforcing concrete bars, is active and the demand is heavier than the works can comfortably meet. The market requirements of alloy and special steels are also on a huge scale, chiefly on account of Government orders.

The Midlands and South Wales

Although there is no shortage of steel the requirements of consumers are on a heavy scale, and the whole of the present record production of the works is passing rapidly into consumption. By far the greater proportion of the output is absorbed on work of national importance and the demand for this purpose appears to be increasing. Efforts are being made by the steelworks to provide a certain amount of steel for commercial purposes, but, of course, a large number of projects were dropped upon the outbreak of war. In any event, it is realised that the preference accorded to certain classes of work is necessary, and users appear to have resigned themselves to late deliveries. It is, however, noticeable that in some instances their requirements have been met much more readily than they expected. The request for structural material is insistent and huge tonnages of joists and sections are passing into use. The constructional engineers are taking large quantities, and big deliveries of plates are being made to the tank, boiler, and locomotive makers. The pressure for supplies of bars is unrelaxed and the works are being subjected to considerable pressure by consumers anxious to obtain material. The question of deliveries is, of course, guided by the regulations regarding preference, and in the case of most works there is little surplus for ordinary commercial needs when priority demands have been satisfied. The re-rolling works are in full operation and, although their supplies of billets and sheet bars have been rationed, they are obtaining fairly regular deliveries. The demand for the small bars and structural steel produced by this industry seems to be continually growing, and an active business is also passing in reinforced concrete bars. In the South Wales district the tinplate industry is working at as high a rate as the supplies of steel will permit. The latest returns show that the works are operating at 70·38 per cent. of capacity. The production of sheet and tinplate bars is being pressed to the utmost, but even so it is not sufficient to meet consumers' full requirements. The galvanised sheetmakers will have plenty of work in hand for A.R.P. purposes, and little ordinary commercial business can be accepted. The output of structural steel is maintained at a high level and all the constructional engineers appear to have work in hand sufficient to last them for several months.

Copper and Tin

Conditions in the copper market are still difficult in the sense that merchants are unable to carry on their business owing to the restrictions imposed by the Control. These continue to give much dissatisfaction, particularly to the members of the London Metal Exchange. In the ordinary sense of the word there is no market for electrolytic copper since only the Control is able to supply. Consumers also find the position irritating as they had become accustomed to dealing with certain suppliers and object to their old associations being disturbed by what many of them regard as unnecessary restrictions. The position is, of course, complicated by the fact that in neutral countries the price of copper stands at between £65 and £70 compared with £51 in this country; but of course no exports are permitted. The opinion is held in merchant circles that the Control has fixed the price at rather too low a level. The Metal Exchange is negotiating with the Ministry of Supply and it is understood that progress is being made with a plan for closing open positions. The request by the Metal Exchange for a general licence has, so far, not been granted. It is pointed out that it will be necessary to give some indemnity to the members of the Metal Exchange against claims which clients, who have had their positions arbitrarily closed as a result of Government action, may make at the end of the war. Some difficult situations arose at the close of the last war as a result of such action by clients. Buying in the United States has been active and in some instances contracts have been entered into for delivery up to March, 1940. Neutrals who formerly bought through London now, of course, have to find another market, and this has helped to swell the volume of American trade. . . . Prices in the tin market have remained fairly steady. This is the only "free" market, but at the same time owing to the regulations establishing a maximum price the position is artificial. The publication of the statistics had practically no influence upon the market, although they showed a considerable increase in the visible supply. According to Mr. W. H. Gartsen's figures the increase was 1373 tons to 21,708 tons. It is believed that American consumers have bought sufficient to cover their requirements well forward, and a decline in the demand from this quarter is expected. The statistics show that the carry over in the Straits Settlements totalled 3774 tons, and in the European smelters 4479 tons. The supplies in September were 10,006 tons compared with 7970 tons in August, whilst the deliveries were 8633 tons against 10,289 tons. Of the latter Great Britain took 1436 tons and the United States 5050 tons.

Lead and Spelter

The position of these two metals is similar, inasmuch as the markets remain suspended. Consumers are receiving supplies direct from the Control, but there is some dissatisfaction that they do not always get their exact requirements either as regards brands or delivery. It is to be hoped that arrangements will be reached between the Ministry of Supply and the London Metal Exchange by which the severity of the regulations as regards merchant trading will be mitigated. The question of issuing a general licence has been pressed by metal merchants, and would receive considerable support from consumers. Whilst there has been a certain tightness in obtaining supplies of lead for some forward dates this is likely to be only temporary, as it is understood that the whole of the Empire production will be available for war purposes, and there has been no serious interruption to supplies. The demand for lead in the United States has been vigorous, and in September it is said that deliveries totalled more than 50,000 short tons. The American Bureau of Metal Statistics gives the world's output of refined lead in July as 153,237 tons. For the first seven months of this year production was 1,097,997 tons, compared with 1,072,414 tons for the corresponding period of 1938. . . . The demand for spelter is on a very important scale. Consumers appear to be getting as much metal as they require, but apparently they cannot always get the brand to which they are accustomed. Supplies appear to be coming to hand freely, and there seems to be no likelihood of any scarcity developing. The producers of galvanised sheets are taking considerable quantities, and as their output of material for A.R.P. purposes is likely to continue for some time, an outlet in this direction seems assured. In the United States there is a strong demand, and the sheet works are now operating at 71 per cent. of capacity, the highest rate for two years. According to reports from America the export demand for galvanised sheets is increasing considerably and at the same time the brass manufacturers are operating at a high rate. In Belgium, on the contrary, some of the zinc smelters are reported to have closed down owing to the difficulties of conducting export business both as regards shipments and prices.

Non-Ferrous Metal Average Prices

The average non-ferrous metal prices for September, published by the London Metal Exchange, show gains in all departments except in the case of tin in which there was some irregularity. The quotation for cash copper for September was £1 5s. 7d. higher than in the previous month whilst for three months the average quotation was £1 3s. 8d. better. The average for electrolytic showed little change, being only 1s. 9d. above the August level, whilst wire bars were 8s. 4d. and best selected 18s. 7d. higher. The average quotation for cash tin showed a decline of 10s. from that of the previous month, but for three months the average rose by £3 1s. 2d., the settlement average being 10s. 4d. better than for August. In the case of lead the average quotation for shipment in the current month was 11s. 9d. above the August figure and for shipment in the third following month 14s. 10d. higher, the mean average being 3s. 4d. better than for August. Spelter average prices also showed an advance over the August figure, the September average for shipment in the current month being 7s. 6d. and in the third following month 4s. 10d. higher, the mean being 6s. 2d. better than in August. The following are the London Metal Exchange official average prices for September :—

Standard Copper	Cash (mean)	£46	0	0
	3 Months (mean)	£46	0	0
	Settlement	—		
Electrolytic Copper (Mean)		£51	0	0
Ditto Ditto	Wire Bars	£51	0	0
B.S. Copper (mean) c.i.f.		£49	10	0
Standard Tin	Cash (mean)	£229	8	9
	3 Months (mean)	£228	7	5
	Settlement	£229	9	8
Lead	For shipment the current month (mean)	£16	12	6
	For shipment the third following month (mean)	£16	12	6
	Mean	£16	12	6
	Settlement	—		
Spelter	For shipment the current month (mean)	£15	0	0
	For shipment the third following month (mean)	£15	0	0
	Mean	£15	0	0
	Settlement	—		

Tin Production.—In a circular issued by Messrs. C. S. Trench and Company of New York, it is shown that the visible supplies of tin are now more than double those in 1914–1918, and that production capacity far exceeds consumption. Between 1914–1918 average production from various sources was 130,000 short tons and at present it is 235,000 short tons.

Current Prices for Metals and Fuels

Official maximum home trade prices, per ton, delivered buyers' stations. *Joists, Sections, Bars and Plates are subject to a rebate of 15s. to home users purchasing only from Associated British Steelmakers. †Export prices are for Empire Markets; for other Markets British quotations conform to Cartel prices.

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
Foundry home prices, except for Scotland, less rebate of 5/-. (*D/d Teesside Area.*)		
N.E. Coast—		
Hematite Mixed Nos.	5 15 6	—
„ No. 1	5 15 6	5 15 6
Cleveland—		
No. 1	5 1 6	5 1 6
No. 3 G.M.B.	4 19 0	5 0 0
No. 4 Foundry	4 18 0	—
Basic	4 12 6	—
Midlands—		
Staffs— (*Delivered to Black Country Station.*)		
North Staffs Foundry	5 1 0	—
„ „ Forge	4 18 0 to £5 0 0	—
Basic	4 12 6	—
Northampton—		
Foundry No. 3	4 18 6	—
Forge	4 15 6 to £4 17 6	—
Derbyshire—		
No. 3 Foundry	5 1 0	—
Forge	4 18 0 to £5 0 0	—
Scotland—		
Hematite, f.o.t. furnaces	5 15 6	—
No. 1 Foundry, ditto	5 3 0	—
No. 3 Foundry, ditto	5 0 6	—
Basic, d/d	4 12 6	—
N.W. Coast— Hematite Mixed Nos.	5 15 6 d/d Glasgow; 6 1 0 „ Sheffield; 6 7 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs and Yorks—		
Crown Bars	12 5 0	—
Best Bars	12 15 0	—
Midlands—		
Crown Bars	12 5 0	—
Marked Bars (Staffs)	15 5 0	—
No. 3 Quality	10 17 6	—
No. 4 Quality	11 7 6	—
Scotland—		
Crown Bars	12 5 0	12 5 0
Best	12 15 0	12 15 0
N.E. Coast—		
Crown Bars	12 5 0	12 5 0
Best Bars	12 15 0	12 15 0
Double Best Bars	13 5 0	13 5 0
Northern Ireland and Free State—		
Crown Bars, f.o.q.	12 17 6	—

STEEL.

	*Home. £ s. d.	†Export. £ s. d.
London and the South—		
Angles	10 10 6	10 0 0
Tees	11 10 6	11 0 0
Joists	10 10 6	10 0 0
Channels	10 15 6	10 5 0
Rounds, 3in. and up	11 10 6	11 0 0
„ under 3in.	11 17 6‡	11 0 0
Flats, under 5in.	11 17 6‡	11 0 0
Plates, ¼in. (basis)	10 15 6	10 2 6
„ 5/16in.	11 0 6	10 7 6
„ ⅜in.	11 5 6	10 12 6
„ 7/16in.	11 10 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 13 0	11 12 6
North-East Coast—		
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 10 6	10 2 6
„ 5/16in.	10 15 6	10 7 6
„ ⅜in.	11 0 6	10 12 6
„ 7/16in.	11 5 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 8 0	11 12 6
Midlands, and Leeds and District—		
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 16 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 13 0	10 2 6
„ 5/16in.	10 18 0	10 7 6
„ ⅜in.	11 3 0	10 12 6
„ 7/16in.	11 8 0	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 10 6	11 12 6

STEEL (*continued*).

	*Home. £ s. d.	†Export. £ s. d.
Glasgow and District—		
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 10 6	10 2 6
„ 5/16in.	10 15 6	10 7 6
„ ⅜in.	11 0 6	10 12 6
„ 7/16in.	11 5 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 8 0	11 12 6
South Wales Area—		
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 13 0	10 2 6
„ 5/16in.	10 18 0	10 7 6
„ ⅜in.	11 3 0	10 12 6
„ 7/16in.	11 8 0	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6

Ireland—f.o.q.—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	10 13 0	10 15 6
Tees	11 13 0	11 15 6
Joists	10 13 0	10 15 6
Channels	10 18 0	11 0 6
Rounds, 3in. and up	11 13 0	11 15 6
„ under 3in.	12 0 0‡	12 2 6
Plates, ¼in. (basis)	10 15 6	10 18 0
„ 5/16in.	11 0 6	11 3 0
„ ⅜in.	10 5 6	11 8 0
„ 7/16in.	11 12 6	12 10 0
Un. 7/16in. to ½in. incl.	11 12 6	11 12 6

‡ *Rounds and Flats tested quality; untested, 3s. less.*

OTHER STEEL MATERIALS

Sheets.	Home. £ s. d.	Export, f.o.b. £ s. d.
11-G. and 12-G., d/d	13 15 0	11-G. to 14-G. 11 5 0
13-G., d/d	14 2 6	15-G. to 16-G. 11 15 0
14-G. to 20-G., d/d	14 10 0	17-G. to 18-G. 12 0 0
21-G. to 24-G., d/d	14 15 0	19-G. to 20-G. 12 5 0
25-G. and 26-G., d/d	15 10 0	21-G. to 22-G. 12 17 6

South Africa, Rhodesia, Nyasaland, £14; Canada, £14 12s. 6d., f.o.b. basis. Irish Free State, £14 15s., f.o.q., 4-ton lots.

The above home trade sheet prices are for 4-ton lots and over; 2-ton to 4-ton lots, 7s. 6d. per ton extra; and under 2-ton lots to 10-cwt., £2 per ton extra.

Galvanised Corrugated sheets, basis 24-G.—

Home.	£ s. d.
4-ton lots and up	17 5 0
2-ton to 4-ton lots	17 12 6
Under 2 tons to 10 cwt.	19 5 0

Export: General, £15 15s., f.o.b., 24-G. basis. South Africa, £16 5s. f.o.b.

Tin-plates—

20 by 14 basis, f.o.t., Bristol Channel Ports, 20s. 4½d.

Tin-plate Bars, d/d Welsh Works, £7 5s.

Billets—100-ton lots and over, 35 to 100 tons, 5s. extra; less than 35 tons, 10s. extra.

	£ s. d.
Soft (up to 0·25% C.), untested	7 7 6
„ „ „ tested	7 12 6
Basic (0·33% to 0·41% C.)	7 17 6
„ Medium (0·42% to 0·60% C.)	8 10 0
„ Hard (0·61% to 0·85% C.)	9 0 0
„ „ (0·88% to 0·99% C.)	9 10 0
„ „ (over 0·99% C.)	10 0 0
Rails, Heavy, 500-ton lots, f.o.t.	9 3 0
„ Light, f.o.t., up to and including 25 lb. per yard	11 2 6

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	4/5 per lb.	
Ferro-Tungsten	4/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	7/6
„ „ 6 p.c. to 8 p.c.	£23 5 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 5 0	7/6
„ „ Max. 2 p.c. carbon	£36 0 0	11/-
„ „ „ 1 p.c. carbon	£38 5 0	11/-
„ „ „ 0·5 p.c. carbon	£41 0 0	12/-
„ „ „ carbon-free	10d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 scale 6/- p.u.	
„ Vanadium	14/- per lb.	
„ Molybdenum	4/10 per lb. 5/- forward	
„ Titanium (carbon-free)	9d. per lb.	
Nickel (per ton)	£185 to £190 per ton	
Cobalt	8/6 to 8/9 per lb.	

NON-FERROUS METALS.

(*Official Prices, October 10th.*)

	Home.	Export.
Copper—		
Electrolytic	£51 c.i.f. U.K. ports	
Billets	£55 „	
Cakes	£51 12 6 „	
Cathodes	£50 10 „	
Wire rods	£55 d/d buyers' premises	
Sheets, Hot rolled	£86 0 0	
Tubes, Solid Drawn (basis)	13½d.	13½d.
„ Brazed (basis)	13½d.	13½d.
Brass—		
Ingots, 70/30, d/d Birmingham	£46 0 0	
Tubes, Solid Drawn 2/1 Alloy	12½d.	12½d.
„ Brazed	14½d.	14½d.
Tin—		
Cash	£230 0 0	
Three Months	£230 0 0	
Spelter—		
G.O.B. Foreign	£15 ex ship, London (duty for buyers' account).	
Empire zinc	£17 5 ex ship, London.	
Lead—		
Pig lead, foreign	£16 12 6 ex ship (duty for buyers' account).	
Empire lead	£17 ex ship.	
Aluminium Ingots (British)	£94 (net)	

FUELS.

SCOTLAND

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—	
Navigation Unscreened	19/- to 19/6
Hamilton Ell	17/6 to 18/
Splints	20/6
Ayrshire—	
(f.o.b. Ports)—	
Steam	17/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	18/6
Unscreened Navigation	19/- to 19/6
Lothians—	
(f.o.b. Leith)—	
Hartley Prime	18/-
Secondary Steam	17/6

ENGLAND

South Yorkshire, Doncaster—	
Steam Hards	19/- to 20/-
Washed Smalls	16/- to 17/-
Northumberland, Newcastle—	
Blyth Best	19/- to 19/6
„ Second	18/- to 18/6
„ Best Small	15/6
Unscreened	17/- to 18/-
Durham—	
Best Gas	19/9
Foundry Coke	26/- to 28/-

SOUTH WALES

Cardiff—	
Steam Coals:	
Best Admiralty Large	23/6 to 24/-
Best Seconds	23/- to 23/6
Best Dry Large	23/- to 23/6
Ordinaries	23/-
Bunker Smalls	16/- to 17/6
Cargo Smalls	15/- to 15/6
Dry Nuts	27/6 to 28/-
Foundry Coke	35/- to 42/6
Furnace Coke	30/- to 33/6
Patent Fuel	25/6
Swansea—	
Anthracite Coals:	
Best Large	35/- to 38/-
Machine-made Cobbles	38/6 to 42/6
Nuts	40/- to 45/-
Beans	33/- to 40/-
Peas	27/6 to 30/-
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large Ordinary	22/6 to 24/6

FUEL OIL.

Inland consumption: supplies in bulk: exclusive of Government tax of 1d. per gallon (other than for use in Diesel-engined road vehicles).

Ex River Thames Installation—	Per Gallon.
Pool Fuel Oil	4d.
Pool Diesel Oil	4¾d.

All supplies are now controlled by the Petroleum Board and all prices are on a day to day basis and subject to alteration without notice.

After a short interval we again print to-day our Current Prices in their usual form. Maximum prices are now fixed and as there would be little point in reprinting the same page week after week we propose to give it only at intervals as and when important changes occur. As usual loose sheets will be sent to subscribers who notify us of their wish to have them. We may add that market changes are mentioned weekly in our Market Notes.

French Engineering Notes

(From our own Correspondent in Paris)

Railway Travel Improvements

ONE month after the mobilisation, the Minister of Public Works, Monsieur de Monzie, was able to give some idea of the achievement of the National Railway Company in maintaining a minimum service in the public interest while the railways were requisitioned for the abnormal requirements of military transport. During the first week 1500 trains were run for the evacuation of populations from the frontier departments to the central regions of France, and the number of trains for public service was steadily increased until, at the beginning of October, it was possible to resume a limited number of express trains on all the main lines. From Paris there are expresses to Hendaye, Marseilles, Vintimille, Strasbourg, Cherbourg, and other important towns, as well as an acceleration of the Orient Express. Between Paris and Dieppe there is a daily express each way, the morning outward-bound train taking 3 hours 10 minutes for the journey and the evening train back 3 hours 18 minutes. Three express trains run each way daily between Paris and Havre, the outward time being 3 hours 37 minutes, and only two or three minutes more for the return. There are also three expresses each way between Paris and Calais which take 5 hours 7 minutes for the journey, except the evening train from Paris, which reduces the time by 7 minutes. Monsieur de Monzie affirms that the railway service is now about two-thirds of the normal, but it does not provide the same acceleration, and all expresses stop at some intermediate stations. The rapides have not been restored. Under present conditions the service is as good as can be expected, though still liable to be interfered with by military requirements. The public is invited to use the railways as little as possible, and Monsieur de Monzie complains of the way in which people evacuated from Paris are returning. Another interesting statement by the Minister is to the effect that the National Railway Company proposes to carry out certain reforms in the services and the trains, notably by providing more general comfort in travelling. Trains in France are still made up with three classes of coaches, but following upon the increases in fares, and the necessity for everyone to economise in view of rising prices, practically all passengers travel third class. Except for the big expresses there is hardly any train with more than two first and second class coaches, the first class generally sharing a coach with the second class. It may be presumed, therefore, that one of these classes will be suppressed, and that there will not be so wide a disparity in comfort between the two remaining classes as exists at present. Third class coaches badly need improvement in this respect, and it should be possible to provide adequate comfort now that the greater part of the rolling stock will have to be renewed.

The Artisan Crisis

Handicraftsmanship as understood in the higher scale of artisan organisation, with its professional qualifications entitling independent skilled workers to belong to the confraternity, has a bearing on the lighter branches of engineering production that should not be overlooked. An artisan of this class must be an artist in his trade and highly skilled, producing goods of individuality and quality, and appealing to buyers who are prepared to pay for goods of distinctive merit. He belongs to a middle class of producers between the big industry and the smaller artisans who are, for the most part, individual workers in association for relief from fiscal burdens that fall on industry generally. For many years the middle class artisan confraternity has been reorganised over most of the Continent on a social basis with international co-operation, and its aim has always been to attain the highest standard of quality of production. It is this ideal that stands out as a measure of achievement in all industries. A handicraftsman in art metal work, for example, sets a standard which the mass production manufacturer cannot hope to equal but is obliged to get as near to it as he can. The middle class artisan production can only find an outlet among buyers who will pay more for goods that are valued for professional initiative and taste, sound workmanship, and quality. A crisis has now arrived when that class of buyer has wholly disappeared. The situation of the artisan was already becoming difficult from the time that the financial stagnation and lessening incomes favoured the lower quality goods, and when armament manufacture was accelerated there were complaints from artisan associations that master craftsmen were going into factories in response to the demand for skilled workers. Since the outbreak of war the Federation of Syndicates of French Artisans sought to obtain work for its members by a participation in orders for national defence. This would necessitate an organisation that does not appear yet to be feasible. For the moment, the situation of the artisan is critical. The general character of the crisis is seen in arrangements that are being made by the Government of the Swiss Confederation for the relief of artisans, who represent the greater part of the industrial population and contribute largely to the country's export trade. Alike in Switzerland and in France the artisan class will experience a difficult time during the war and all through its after-effects until the world settles down to a state of confident commercial collaboration. There can be no suppression of handicrafts in individualist countries, however much big industry may grow, and it is all to the good that handicraftsmanship should grow with it. On the other hand, the existence of the artisan is stated to be seriously threatened in Germany where, nevertheless, the movement which extended over the greater part of the Continent first took shape and exacted high qualifications from master craftsmen and imposed conditions of apprenticeship that were calculated to give increasing vitality to middle class industry. The collective system now adopted in Germany has much in common with that of the Soviets, so far as the submerging of individualism is concerned. A grouping of industrial and commercial effort under State control tends to the suppression of the artisan and the small trader. When a country becomes a vast State industrial machine it loses the human factor that means so much for progress, and this is recognised in the other totalitarian country where the artisan movement is fostered as necessary to the national welfare.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

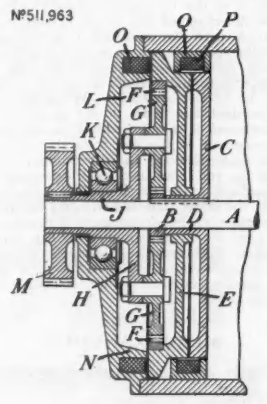
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2 1s. each.

The date first given is the date of application ; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS

511,963. February 28th, 1938.—EPICYCLIC VARIABLE SPEED-GEARING FOR USE WITH DYNAMO ELECTRIC MACHINES, C.A.V.-Bosch, Ltd, of Warple Way, Acton, London, W.3, Stanley Frederick Heathwood Parsons and William Henry Glaser, both of the Company's address.

This invention relates to dynamo electric machines of the kind used in conjunction with internal combustion engines and adapted to serve for both starting the engine and for generating electric current. The object of the present invention is to provide an improved combination of epicyclic mechanism and electromagnetic clutches. The accompanying drawing is a sectional elevation of electromagnetically controlled epicyclic mechanism constructed in accordance with the invention. The inventors secure on the armature spindle A of the dynamo electric machine a sun pinion B and at one side of this pinion they secure to the spindle an iron disc C. On a central boss D of this disc or on a portion of the spindle A lying between the disc and sun pinion they mount another iron disc E which is slidable and rotatable relatively to the spindle, this second disc having mounted on it an internally toothed annulus F. This annulus and the sun pinion B are interconnected by a planet pinion or pinions G mounted on a planet carrier H formed on one end of a sleeve J supported by a ball or other bearing K in the machine case L and having secured on its outer end a wheel M whereby it is connected to the engine, the sleeve J being coaxial with and adapted to support the armature

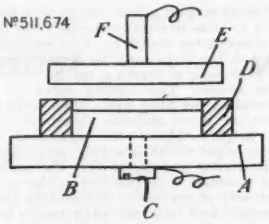


spindle A. Adjacent to the iron disc E carrying the annulus F is arranged in or formed on the interior of the casing L of the machine a stationary annular iron part N, and within the casing and embedded in suitably shaped iron shrouds are mounted a pair of stationary annular electromagnetic windings O, P. In the example shown the winding O is embedded in and shrouded by the stationary iron part N, and the winding P is embedded in and shrouded by another stationary annular iron part Q, arranged within the casing L so as to surround the adjacent portions of the discs C, E. The various iron parts are suitably shaped and arranged to co-operate with the electromagnetic windings so that on exciting the winding O the iron disc E carrying the annulus F is pulled magnetically towards the adjacent stationary iron part N and is thereby held against rotation. Motion imparted to the armature spindle A is then transmitted at a reduced speed to the engine through the sun and planet pinions B, G, the annulus F being stationary. When it is required to transmit motion from the engine to the armature the winding O is put out of action and the other winding P is excited. The flux provided by the latter winding passes through, and has the effect of pulling and holding together, the iron parts E, C, associated with the annulus F and sun pinion B. The epicyclic mechanism then rotates as one piece. By this invention it is possible to provide an epicyclic mechanism in combination with electromagnetic controlling means in a very simple and convenient manner.—*August 28th*, 1939.

SWITCHGEAR

511,674. February 26th, 1938.—ELECTRIC SWITCHING DEVICES, PARTICULARLY DESIGNED FOR PREVENTING INTERFERENCE WITH RADIO APPARATUS, Frederick Richmond Wentworth Strafford and Belling and Lee, Limited, both of the Company's address, Cambridge Arterial Road, Enfield, Middlesex.

This invention has for its object the provision of a switching device which when operated does not instantaneously reduce the current to zero value. It is well known that the rapid making or breaking of a current in a circuit may give rise to



radiated electrical interference, and the object of the present invention is to overcome or minimise the effect of such interference. A base plate or supporting member A locates a contact B which is held by a bolt C to which a connecting lead may be attached. The contact member B is surrounded by an annular pad D which is saturated with an electrolyte. The pad D is conveniently composed of aerated rubber, felt, or similar material. The height of the pad is greater than that of the contact B. A movable contact member E provided with an operating rod F is normally positioned above the pad. When the operating rod F is actuated by any convenient means, the contact E engages the top edge of the pad D and establishes electric contact with the member B through the electrolyte contained in the pad. As the contact D is moved towards the member B the ring pad D will be compressed until the contact E engages the surface of the fixed contact member B. Any known electrolyte may be employed and if desired glycerine may be added to the electrolyte to prevent evaporation. It is also to be understood that a protective cover may be provided which tends to minimise evaporation and also prevents contamination of the electrolyte. Any known mechanical or electrical means may be employed to operate the device without exceeding the scope of the invention.—*August 28th*, 1939.

ELECTRICAL APPLIANCES

511,159. February 14, 1938.—CIRCUIT ARRANGEMENTS, INCLUDING DRY RECTIFIERS, Automatic Telephone and Electric Company, Ltd., Norfolk House, Norfolk Street, London, W.C.2, Arthur Edward Caswell, "Petit Tor," 54, Church Road, Wavertree, Liverpool, and Cecil Frederick Lawrence, "Mansard," Neston Road, Burton, Neston, Wirral.

The invention relates to circuit arrangements involving the use of dry contact rectifiers, for instance of the cuprous oxide type which now find considerable employment in many branches of electrical engineering. The chief object of the invention may be said to be the provision of means whereby the general efficiency of such arrangements may be improved and their possibilities of use increased. According to this invention, a unit of non-linear resistance material having a resistance which is substantially the same for both directions of current flow but varies with the applied voltage while its temperature remains substantially constant, is connected in parallel with a dry contact rectifier in order to prevent damage to the rectifier by the application of a voltage in excess of that for which it was designed. The non-linear resistance material employed is preferably of the type which maintains a high resistance as long as the applied voltage does not exceed a critical value, but which when subjected to a higher voltage breaks down and passes a considerable current. The resistance of the material is moreover unaffected by the polarity of the applied voltage. One material having these properties consists of a mixture of silicon carbide with carbon and/or tungsten or molybdenum which is agglomerated under pressure and subsequently baked, the resulting mass having a resistance-current characteristic which is substantially hyperbolic. The resistance material may be made into various shapes to form a unit. For instance, it may be made into the form of a disc or washer and the surface metal-sprayed at appropriate points as described in Specification No. 493,375. —*August 4th*, 1939.

511,683. January 19th, 1938.—CONTROL DEVICES FOR ELECTRIC MOTORS, Albert Edward Leek, of "Stilecroft," Workington, Cumberland.

An object of this invention is to provide a greater degree of safety in mines, factories, or like places, operating under conditions of an explosive atmosphere. An electric motor A for driving a coal cutter or any other device receives its electric power from cables B remotely controlled by a starting mechanism or switch C, the operating circuit of which is adapted to be made or broken by the displacement of a piston D in a cylinder E connected to a fluid pipe line F, the pressure in which is different to atmosphere. This pipe line may therefore include either air under a partial vacuum or air under pressure, but will usually include water under pressure and is provided with a number of relief valves G disposed at any convenient place. The conduit F is connected to a main conduit H. It will consequently be seen that should any of the relief valves G be opened there will be an immediate reduction in pressure in the conduit F which will allow the spring J to operate and open the circuit of the motor A. It will be preferred that a reversing switch

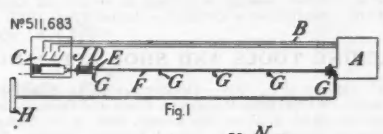


Fig. 1

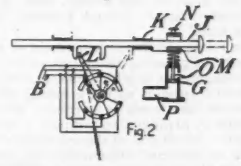


Fig. 2

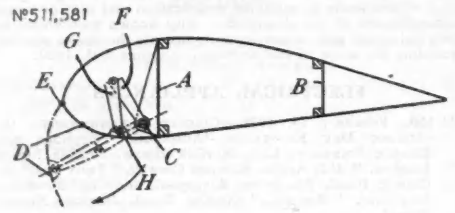
such as is shown diagrammatically at Fig. 2 be interconnected with a relief valve G so that this reversing switch cannot be operated until the relief valve G is operated and therefore no reversal of the circuit of the prime mover A can ever take place when the electric conductors B are alive. In the form of switch shown by way of example, in Fig. 2 of the drawings, a hand operating slide J is carried in guides K on the motor casing. This slide J operates a reversing switch lever L, controlling the three phase line B and is normally held locked by a spring bolt M having a press button N, which bolt operates a release valve O, on a fluid pressure pipe P, connected at a remote point to a fluid pressure relay operating the main switch on the lines B. It will consequently be seen that operation of the slide J is only possible when no current is on the line B. The fluid system may be pneumatic or hydraulic and the fluid used may be air, water, or oil, taken by way of example. This fluid system will be provided with operating valves at the points G from where it is desired to effect the control of the electric motor, solenoid, or the like, whilst at the remotely situated controller, pistons or plungers will be connected either directly or indirectly to the displaceable elements of variable resistances, rheostats, switches, or the like.—*August 23rd*, 1939.

AERONAUTICS

511,581. February 19th, 1938.—DRAG FLAPS FOR AEROPLANE WINGS, The Bristol Aeroplane Company, Ltd., and Leslie George Frise, both of Filton House, Bristol.

It is already known to provide trailing-edge flaps on an aeroplane wing for the purpose of increasing the lift and drag on the aeroplane when landing. Such known flaps increase the pitching moments on the aircraft to an extent which, although unimportant at the comparatively low speeds of landing, becomes serious at high air speeds. It has also been proposed to provide flaps at or adjacent to the leading edge of the wing on the underside thereof to act as air-brakes. The object of this invention is to enable a flap of this type to be effectively used during dive-bombing to reduce the terminal velocity of the dive without imposing unduly heavy loads on the wing structure ; and to ensure that the structure itself is capable of absorbing the loads imposed upon it. One embodiment of the invention is described with reference to the accompanying drawing. The wing comprises a front spar A and a rear spar B. Between the front spar and the leading edge of the wing a tubular operating shaft C runs spanwise of the wing and is borne in suitable brackets carried by the spar. At the leading edge of the wing a flap D is pivoted by means of a hinge E running along the wing, the flap normally occupying the position shown in full lines in which

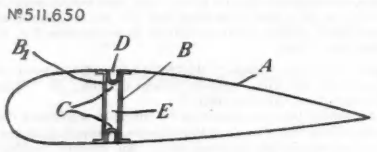
it constitutes the undersurface of the leading portion of the wing between the hinge and the lower boom of the spar. The shaft carries one or more crank-arms F each of which constitutes one member of a toggle linkage the other member G of which is pivoted to a bracket H affixed to the internal surface of the flap. The linkage is of the well-known type which, when straightened, as shown in dotted lines, to a position slightly beyond its dead-centre position, is locked against further move-



ment by the interengagement of its stop members. When the aeroplane dives, the pilot rotates the shaft through the intermediary of a hydraulic motor and the toggle linkage is straightened and the flap rotates about the hinge into the position shown in dotted lines. The flap may be retracted by rotating the shaft in a clockwise direction whereby the flap returns to the position in which it constitutes a part of the undersurface of the wing.—*August 21st*, 1939.

511,650. August 5th, 1938.—Arrangements for Sucking off the Boundary Layer from Aerofoils, Willy Messerschmidtt, of Gentnerstrasse 24, and of Haunstetterstr 118a, Augsburg, Germany.

The present invention relates particularly to the supporting wings of aeroplanes. In order to increase the lift and decrease the drag of such surfaces, it has already been proposed to provide devices for sucking off the boundary layer. According to the invention the walls of the suction passages are constituted by one or more stressed elements of the wing structure, such as hollow stringers, or solid or hollow spars, preferably in cooperation with parts of the stressed skin, the suction slots being arranged in the range of the cross-sections of the stressed elements that form the walls of the passages. Referring to the

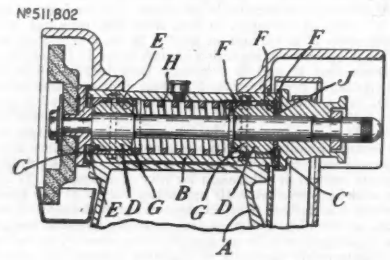


drawing A is a single-spar wing, the spar of which is constituted by two members B and B_1, both these members being U-shaped in cross-section and connected with each other by members C. A sucking slot D is provided in the wing in the range of the internal cavity of the spar, which cavity is connected with a sucking fan or the like not shown in the drawing. For this purpose either the space formed by the wing covering and the spar part C is in communication with the fan; or alternatively the internal space E inside the spar B, B_1 is connected to the fan, in which case the connecting member C is made with holes in it. From this example it will be apparent that by the twofold utilisation of the wing stiffening members, such as the spar, which apart from its normal stiffening function is also utilised as a suction passage, a decrease in weight and simplification of the construction is attained.—*August 22nd*, 1939.

MACHINE TOOLS AND SHOP APPLIANCES

511,802. March 19th, 1938.—Improvements in Bearings for Shafts of Grinding Machines, Black and Decker, Limited, and Frederick William McCartney, both of the Company's address, Fairlie Road, Slough Trading Estate, Slough, Buckinghamshire.

This invention relates to improvements in or relating to bearings for the shafts of grinding machines and has for an object to provide an arrangement in which closely-fitted plain bearings may be employed for supporting the grinding-wheel shaft and/or the shaft on which the work is carried. The grinding head comprises a cradle A arranged to support a hollow cylindrical bearing housing B. Each end of the cylindrical bearing housing is provided with an internal circumferential groove in which is mounted a removable split spring-ring C of the kind sold under the name of "circlip." A shaft for the grinding wheel extends through the cylindrical housing and is carried by two plain bearings D formed from a self-lubricating metal compound.

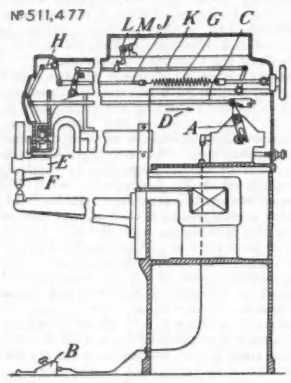


The clearance between the shaft and the bearings may be as low as of the order of 0·0001in. where the diameter of the shaft is at least 1in. It will be noted that each bearing is provided with an external cylindrical surface flanked on either side by part-spherical surfaces E. Each bearing is supported by a mounting formed in two parts F which are spaced apart on either side of a plane transverse to the axis of the shaft and are axially slidable in the housing. Each part also has a part-spherical or conical surface G which is arranged to engage one of the surfaces E of the bearing. A helical compression spring H is arranged to force the mountings against the shoulders provided by the circlips. Axial movement of the shaft within the bearings is prevented by means of a shoulder formed on the shaft and arranged to bear against an end face at the inner end of one of the bearings and by a washer J which is interposed between the other end of the bearing and a pulley which is secured to the shaft. The grinding wheel is carried by a flanged bush at the other end of the shaft.—*August 24th*, 1939.

WELDING

511,477. January 17th, 1939.—Electric Welding Machines, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

The invention relates to apparatus for transmitting the electrode-pressure on resistance spot welding or lap welding machines of that type in which in the first instance the electrode stroke is effected by moving a rigid member without any accompanying movement of the flexible member required for the pressure-transmission, and after the electrode is applied upon the workpiece the electrode-pressure is produced by further moving the rigid member with the flexible member automatically called into play. In this type of apparatus the advantage is obtained that, in contrast with the known welding machines, the flexible member can remain at rest with its bulk so long as the electrode has found no abutment through the workpiece or through the counter-electrode. Quicker operation more free from inertia is rendered possible by the exclusion of the bulk of the flexible member and of the appertaining levers during the stroke. The object of the invention is to provide a machine of the type mentioned having simple and efficient means for applying the electrode pressure after the movable electrode has been applied to the work. The manner of operation of the device is as follows: If, for example, after the work has been brought

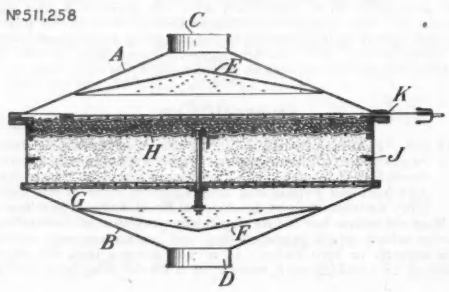


between the electrodes, the crank drive A is set into action through actuation of the foot-operated switch B, then the rod C moves in the direction of the arrow D and thus moves the electrode-stamp E with the electrode F downwardly. During this movement the spring G, which is given a certain preliminary tension, remains perfectly at rest, *i.e.* its bulk and also the bulk of the appertaining lever do not have to be accelerated during the stroke of the electrode. When however, the electrode F has reached the work or an abutment, the further downward movement of the electrode F meets with resistance; the further movement of the rod C in the direction of arrow D therefore produces through the intermediary of the cranked lever H and of the rod J an increased tensioning of the spring G. The electrode F is therefore applied under pressure upon the workpiece. In order that the welding operation may take place after a certain electrode-pressure is reached, the stop on the rod K is moved in conformity with the expansion of the spring G to allow the movable contact L of the switch M to approach the counter-contact, so that after a certain path is travelled the welding current circuit is closed by the switch M.—*August 18th*, 1939.

MISCELLANEOUS

511,258. *December 7th*, 1938.—Improvements relating to Filters, Edgar Rouse Sutcliffe, Sandfield Hall, Lowton, Newton-le-Willows, Lancashire.

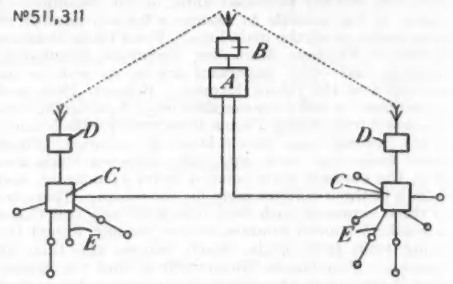
The filters described are particularly those which are provided for use in air-raid shelters and the like for the removal of harmful constituents before air is passed into the shelter. The filter unit comprises a rectangular casing formed of inwardly flanged sheet metal sections having a substantially conically formed or tapering top part or cover A and a similar lower part B. Central openings C, D, are provided in the upper and lower parts of the casing, the opening C comprising the inlet for the gases to be purified, and D the outlet for the purified gases. The air is caused to pass through the filter unit under pressure or by suction. The body of the casing contains the filter material which may be of any kind found suitable and which complies with the requirements. Mounted within the parts A and B are conically formed perforated distributing plates E, F. The plate E serves to distribute the gases evenly over the whole surface of the filter material, and the plate F ensures that an even withdrawal of the purified air through the filter material is effected. The holes in the distributing plates are provided in such manner, at such positions, and of such dimensions relatively to the cross-sectional areas and positions of the inlet and outlet opening that the contaminated gases



are distributed so as to pass substantially over the whole area of the filter and to pass uniformly through the filter material and not solely through the centre or other separate part of the filter. The base of the body may be formed by a horizontal sheet of coarse wire gauze or screen G on the surface of which is disposed a fine screen. The screens serve to support the absorbent material of the filter unit. The body is filled with activated carbon or other suitable absorbent material to a predetermined height. Above the activated carbon and supported at the edges on an inwardly projecting flange is a coarse screen H similar in form to G. The screens compress the carbon and maintain it in position in the casing. A hole is provided centrally of the lower distributing plate to enable a spring compression bolt to be mounted and be readily adjustable. Between the screens, at a mid-position between, a curtain or skirting J is provided to project a short distance inwardly from the walls of the casing into the activated carbon and serving to prevent creeping of the gas or vapours between the activated carbon and the inner walls. Resting on the upper screen is a pad of a standard type formed of a merino wool and asbestos fibre. This pad forms what is known as a "particulate filter" and removes any smokes or arsenical gases from the air passing through the filter. At one side of the casing a gap or slot K is left for the insertion of a pre-filter, of a fibrous material, for screening out any coarse particles which might otherwise pass through the filter.—*August 15th*, 1939.

511,311. May 4th, 1938.—Electrical Systems of Remote Control, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, and James Young Fletcher, of the same address.

This invention applies to the remote control of power consuming devices such as street lamps, water heaters, &c., and the aim of the invention is the provision of a means of controlling such devices from a central point by means of radio frequency and voice frequency currents. The diagram shows a power station A provided with a transmitter B, the power station being associated with distributing stations C, each of which is provided with a receiver D. Each station C supplies a number of power consuming devices but certain of them, such as cookers and domestic appliances, must not be affected by control currents from the power station while other consuming devices such as street lights are to be so controlled. Thus assuming that all



the items of one class of apparatus connected to one station are to be switched, the transmitter B sends out a carrier of a frequency receivable only at the station to be affected, modulated with a particular frequency characteristic of the operation to be performed, this being received on the receiver D. The demodulated carrier causes voice frequency current to be superimposed on one or more feeders E at the station C. Each apparatus unit to be remotely controlled is provided with a vibrator or similar type control relay of the kind disclosed for example in Specification No. 491,980 connected to the supply mains, the control relay being affected by the superimposed control currents to perform the necessary switching operation. All consuming devices not provided with control relays are unaffected by the voice frequency currents. Different operations are performed by changing the frequency of the control current applied to the power lines.—*August 16th*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of Fuel

Thursday, Oct. 19th.—Connaught Rooms, London. Luncheon 12.45 p.m. for 1.15 p.m. Mr. H. A. Humphrey will give a Summary of his Melchett Lecture "The Supply of Explosives during the last War and the Early History of Billingham."

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Oct. 24th.—39, Elmbank Crescent, Glasgow. Presidential Address, W. Ayre. 6.30 p.m.

Iron and Steel Institute

Thursday, Nov. 23rd.—4, Grosvenor Gardens, S.W.1. Statutory Autumn Meeting. 3.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Oct. 13th.—Mining Institute, Newcastle-upon-Tyne. Annual General Meeting and Presidential Address by Major T. Russell Cairns. 5.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS

The Anderson-Grice Co., Ltd., Carnoustie, Scotland, informs us that its London and Glasgow Offices have been closed, and that all correspondence and orders should be sent to Head Office, or to its representatives' private addresses.

The Westinghouse Brake and Signal Company, Ltd., informs us that in consequence of the international situation, the majority of its Departments are removing to Chippenham, and that all correspondence should now be addressed to the Company at Pew Hill House, Chippenham, Wilts. A section of the Staff will remain at York Way, King's Cross, London, in order to maintain contact and to give attention to any urgent technical matters which may arise.

CATALOGUES

British Insulated Cables, Ltd., Prescot, Lancashire.—Publication M 110, "How to repair B.I. trailing cables, types 'K' and 'L.'"

The British Oxygen Co., Ltd., Thames House, Millbank, Westminster, S.W.1.—Technical Information Booklet No. 7 on bronze welding.

A. Reyrolle and Co., Ltd., Hebburn-on-Tyne.—Pamphlet 1099A/9.39 describing induction, electromagnetic, thermal, and auxiliary time lag and tripping relays.

The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.—Photographic electric lamps and G.E.C. equipment for photographic studio lighting.

James Howden and Co. (Land), Ltd., Caxton House, Westminster, London, S.W.1.—Publication describing the Howden vortex cell and Howden scroll type dust collector fan for the dry separation of solids.